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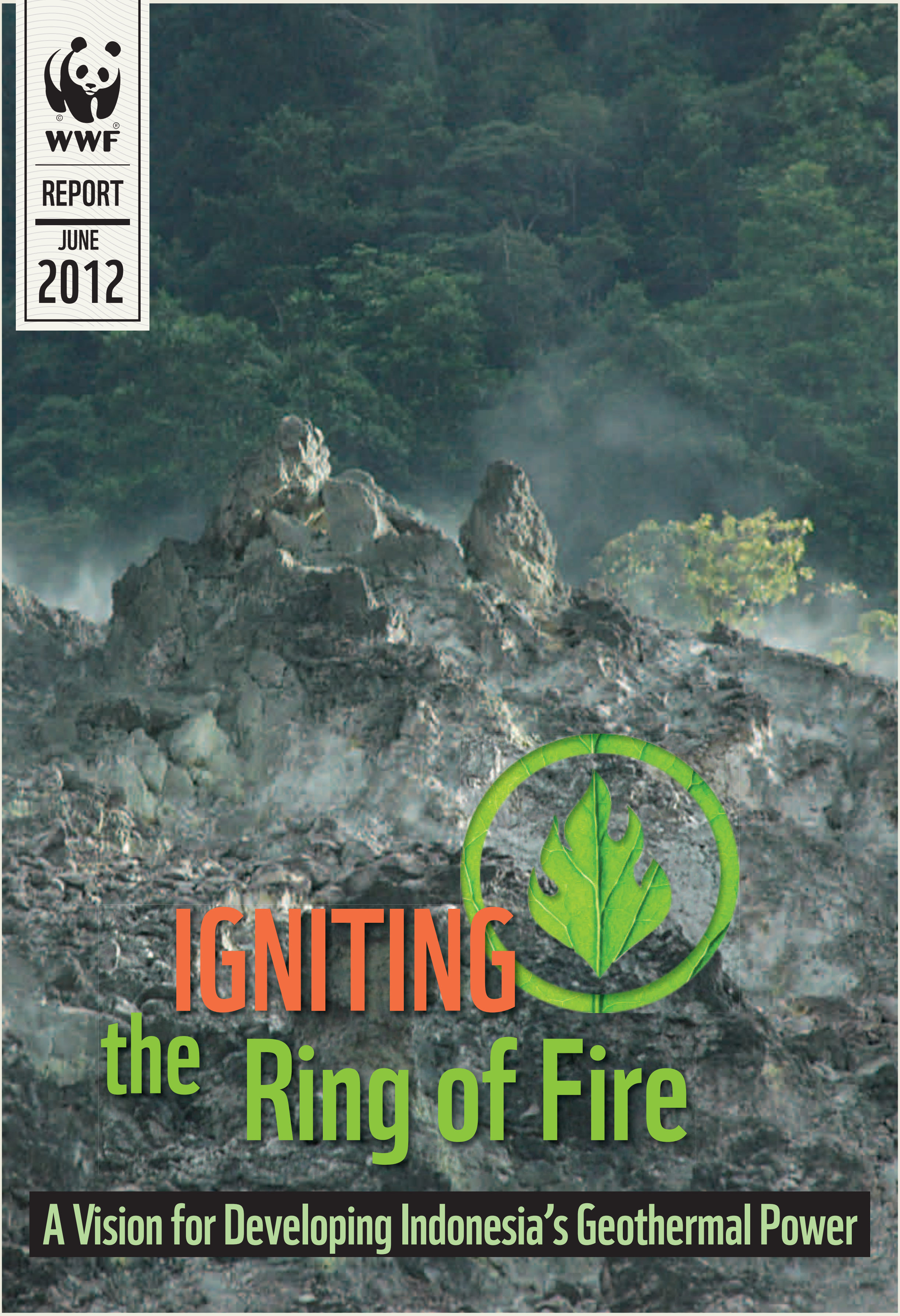

IGNITING the Ring of Fire

A Vision for Developing Indonesia's Geothermal Power

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A Vision for Developing Indonesia's Geothermal Power

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ring OF fire

Photo on cover:
Manado geothermal renewable energy sources.

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FOREWORD

‘A world powered by 100 percent renewable energy by 2050’,

is WWF’s vision in the energy sector for a sustainable living. The study by Ecofys as presented in WWF’s Energy Report shows that it is technically possible for us to get to this point. Achieving our vision would mean getting us in the right path in avoiding catastrophic climate change, decreasing pollution, increasing energy security and improving health for people worldwide.

Energy security, for Indonesia as a developing country, is one of the major challenges to conquer. For many decades, Indonesia has been highly dependent on the luxury of fossil fuel consumption for electricity. To maintain the level of economic growth and meet the demand of a growing population, energy demand is still constantly increasing albeit depleting resources.

Global pressure to fight climate change, for developed and developing countries, is becoming more difficult. Indonesia has voluntarily pledged to reduce its greenhouse gas (GHG) emissions by a minimum of 26% in 2020. Shifting from fossil fuels to renewable energy sources is one of the ways to fulfill this commitment.

The renewable energy pathway is not an option but a necessity for strengthening our energy security and sustainable development. Fortunately, Indonesia is not only rich with fossil fuels but also possesses an abundance of renewable energy sources. Indonesia currently has the biggest world potential of geothermal, with at least 28 Giga Watt potential for exploration while currently only 1.196 Giga Watt is utilized.

WWF’s Geothermal Ring of Fire program has an ambition to shift towards the use of renewable energy, particularly in the sustainable production and use of geothermal energy, in Indonesia and the Phillipines by 2015. We put our concern for transforming geothermal energy as a catalyst for our economy, community empowerment, biodiversity conservation and reduce greenhouse emmissions.

This report presents Indonesia’s challenges and opportunities to be the leader in developing sustainable geothermal options. WWF commits to work with the government, private sector and community to inspire best practices for sustainable geothermal development. We hope through publication of this book, we can contribute to stimulate the accelleration of geothermal utilization in Indonesia. We have choices to transform the world in a good way. Together, we can manage the challenges and create a sustainable future.

Dr. Efransjah
CEO
WWF-Indonesia

ACRONYMS & ABBREVIATIONS

ADB	Asian Development Bank
BAPPENAS	*Badan Perencanaan Pembangunan Nasional* (the State Ministry for National Development Planning/National Development Planning Agency)
BATAN	*Badan Tenaga Nuklir Nasional* (The Nuclear Energy Agency)
BMI	Business Monitor International
BPPT	*Badan Pengkajian dan Penerapan Teknologi* (The Agency for the Assessment and Application of Technology)
C	Celsius (centigrade)
CDM	clean development mechanism
CERs	certified emission reductions
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
DCGS	Dutch Colonial Geological Survey
DEN	*Dewan Energi Nasional* (National Energy Council)
DG	Directorate General
DNPI	*Dewan Nasional Perubahan Iklim* (National Council on Climate Change)
EECHI	Energy Efficiency and Conservation Clearing House Indonesia
EGS	enhanced geothermal systems
EIA	environmental impact assessment
ESDM	*Energi dan Sumberdaya Mineral* (Energy and Mineral Resources)
EUR	Euro
G	gram
GDP	gross domestic products
GENI	Global Energy Network Institute
GHG	greenhouse gas
GIS	geographical information system
GoI	Government of Indonesia
GRS	geothermal resource subzones
GSI	Geological Survey of Indonesia
GW	gigawatts
GWe	gigawatts-electrical
HCV	high conservation value
HCVF	high conservation value forests
ICCSR	Indonesia Climate Change Sectoral Roadmap
IEA	International Energy Agency
IPP	independent power producers
IRESS	Indonesian Resources Studies
ITB	*Institut Teknologi Bandung* (Bandung Institute of Technology)
JBIC	Japan Bank for International Cooperation
JDIH	*Jaringan Dokumentasi dan Informasi Hukum* (Legal Information and Documentation Network)
JICA	Japan International Cooperation Agency
JOC	joint operating contracts
KfW	*Kreditanstalt für Wiederaufbau* (Reconstruction Credit Institute)

kV	kilovolts
kWh	kilowatt-hour
kWhe	kilowatt-hour electric
LCOE	Levelized Cost of Electricity
LPG	liquefied petroleum gas
MEMR	*Kementerian Energi dan Sumberdaya Mineral or Kementerian ESDM* (Ministry of Energy and Mineral Resources)
MoF	Ministry of Forestry
MW	megawatts
MWe	megawatts-electrical
NGOs	non-government organizations
NREL	National Renewable Energy Laboratory
OECD	Organization for Economic Co-operation and Development
O&M	operation and maintenance
Pertamina	*Perusahan Tambang dan Minyak Negara* (the state-owned oil and gas company)
PGE	Pertamina Geothermal Energy
PLN	*Perusahan Listrik Negara* (the state-owned electricity company)
PLTP	*Pembangkit Listrik Tenaga Panas Bumi* (Geothermal Power Plant)
PNOC-EDC	Philippine National Oil Company-Energy Development Corporation
PPA	power purchase agreement
Prolegnas	*Program Legislasi Nasional* (National Legislation Program)
PT	*Perusahaan Terbatas* (Limited Company)
PwC	PricewaterhouseCoopers
RAN GRK	*Rencana Aksi Nasional Penurunan Emisi Gas Rumah Kaca* (National Action Plan for the Reduction of Greenhouse Gas Emissions)
RoF	ring of fire
RUEN	*Rencana Umum Energi Nasional* (National Energy Master Plan)
RUKN	*Rencana Umum Kelistrikan Nasional* (National Electricity Master Plan)
RUKD	*Rencana Umum Kelistrikan Daerah* (Sub-national/Local Electricity Master Plan)
T	temperature
TNGHS	*Taman Nasional Gunung Halimun-Salak* (Gunung Halimun-Salak National Park)
TPES	total primary energy use
TWh	terawatt-hour
UKP4	*Unit Kerja Presiden bidang Pengawasan dan Pengendalian Pembangunan* (the Presidential Unit for Development Monitoring and Oversight)
UMKK	*usaha menengah, kecil dan koperasi* (small, medium enterprises and cooperatives)
UNFCCC	United Nations Framework Convention on Climate Change
UNEP	United Nations Environment Programme
USAID	United States Agency for International Development
US-EIA	United States-Energy Information Administration
VSI	Vulcanological Survey of Indonesia
WKP	*wilayah kerja pertambangan* (mining working area)
WWF	World Wide Fund for Nature

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EXECUTIVE SUMMARY

Indonesia, Southeast Asia's largest energy producer and consumer, boasts enormous renewable energy potential and still little progress has been made in increasing renewable energy use. However with soaring fossil fuel prices, Indonesia's dependence on fossil fuels to power its economy is no longer economically viable.

Research shows that renewable energy sources can meet up to 35 percent of Indonesia's energy needs by 2035 (Leitmann et al. 2009; Marpaung et al. 2012). Geothermal power in particular can play a key role in shaping Indonesia's low carbon future, with the potential to replace coal-fired power plants as a base load electricity source with virtually no emissions (Mackay 2008). The challenge lies in making this transition within the country's existing institutional structures under which the price of fossil fuels is not only heavily subsidized but also centrally set (Ardiansyah et al. 2012).

Geothermal energy development in Indonesia

The country's total potential geothermal resources and reserves are estimated at 28,994 MWe (megawatts-electrical) with an installed capacity of 1,196 MWe (approximately 4 percent of the total resources and reserves).

Of all 276 geothermal areas in Indonesia, a total of 37 can be considered as mining working areas (WKP [*Wilayah Kerja Pertambangan*]), with 7,376 MWe of geothermal potential.

Yet to accelerate the development of geothermal energy is somewhat of a herculean task for a developing country like Indonesia. In 2010, a review commissioned by the Ministry of Energy and Mineral Resources (MEMR) argued that it will be difficult to meet the government target of 3,967 MW of geothermal capacity by 2014, and that the most it can hope to deliver is 2,297 MW (Castlerock 2010). Based on our calculations, Indonesia can realistically achieve 1,700 MWe by 2014, 2,750 MWe by 2020 and 4,000 MWe by 2025. The projected figures, based on the current actual installed capacity, means a mere 57 percent increase by 2015 and 129 percent by 2020.

Positive impacts on energy security, energy poverty and GHG emissions reductions

Energy security

Geothermal energy use can ease Indonesia's high dependency on oil and consequently reduce the burden from heavy fossil fuel and electricity subsidies. According to the Ministry of Finance, energy subsidies in 2012 reached USD 17.7 billion or 168.6 rupiahs, which was 17 percent of total government expenditures. Energy subsidies bring a substantial number of perverse economic impacts; for example, while subsidies are intended to help the poor afford fuel, it is the rich who benefit from it disproportionately (Pallone 2009).

Energy poverty

Indonesia's steady economic growth of more than 6 percent, even during the recent global recession, was accompanied by a 9 percent growth in electricity demand each year (Ministry of Finance 2009; PwC 2011). The country struggles to meet this demand. A significant number of Indonesia's population, primarily those living in rural areas and the outer islands, lack access to electricity.

The government's second-phase crash program, to be implemented between 2009 and 2018, at an estimated cost of USD 21.3 billion (ESDM 2009b), will build 60 percent of new capacity from renewable resources. At least 5,000 MW or 48 percent will be sourced from geothermal energy (Ardiansyah et al. 2012; Girianna 2009), which can help increase access to electricity in the outer islands where most geothermal resources are located (Girianna 2009). It is crucial to note, however, that building geothermal power plants in remote areas requires additional financing to connect electricity production to the main grid (Tanoto & Wijaya 2011).

GHG emissions reductions

Although more than 60 percent of Indonesia's current greenhouse gas (GHG) emissions come from forestry and land-use sectors (Ministry of Environment, 2009), experts predict increased carbon dioxide (CO_2) emissions from electricity generation by 2030, reaching 810 million tonnes of CO_2 equivalent (CO_2e), due to a heavy dependence on coal. This increase of nearly seven times the amount in 2005 (DNPI 2010) will exacerbate climate change impacts to which Indonesia, an archipelagic nation, is already vulnerable to (Ministry of Environment 2009).

Conversely, several studies illustrate the significant GHG emissions savings from an increase in geothermal installed capacity; for example, Wijaya and Limmeechokchai (2009) show that an increase of 10 GW in geothermal energy capacity by 2025 will result in emission savings of approximately 58 million tonnes of CO_2e. Our report also demonstrates that the energy scenario based on the Government of Indonesia's geothermal targets will achieve an annual reduction of 13.6 million tonnes of CO_2 by 2015 and 17.1 million tonnes of CO_2 by 2020. Alternatively, WWF's Ring of Fire geothermal scenario shows an annual reduction of 13.6 million tones of CO_2 by 2015 and 19.8 million tones of CO_2 by 2020.

Other economic gains

Apart from geothermal energy's positive economic impacts on energy security, energy poverty and GHG emissions savings, tapping the country's geothermal potential also brings additional government revenue and employment. In the case of Indonesia, geothermal energy development can generate one million jobs – significantly more than other types of power generation. In our report, we calculate increased employment, based on various energy scenarios, to reach anywhere from 37,000-206,000 by 2015 and 61,000-325,000 by 2020. Another important economic gain of geothermal energy development is its potential to attract further financial investment.

Risks and costs of geothermal energy development

One of the key risks in geothermal energy development is associated with the electricity market. Until recently, Indonesia's geothermal resources have been underutilized partly due to pricing disagreements between the PLN, the state-owned electricity company, and the government. Even when geothermal licenses were granted, developers delayed exploration; waiting for power-purchasing agreements with the PLN, which were in turn on hold in anticipation of the government's pricing approval.

As a temporary measure to resolve tariff discrepancies, the PLN introduced in January 2011 an 18 percent tariff hike ceiling, in line with the MEMR's Regulation No. 7 of 2010. However price increases will not eliminate all risks associated with the electricity market. (Castano, 2011) reported that some investors remain concerned about the ability of debt-ridden PLN to pay higher tariffs as state coffers are already burdened with subsidies for the energy sector.

Another immediate risk is related to the costs of exploration. In geothermal energy development, a drilling project exploring a single location can easily swallow EUR 15-20 million (KfW 2011), which does not take into account costs associated with the risk of non-discovery (KfW 2011). It can then take another ten years to develop a geothermal power plant to the level of commercial operation, with project financing available only in the latter phase of the process (PwC 2011). The fact that geothermal development requires significant up-front equity is a key issue for investors (PwC 2011).

Yet more fundamental to increasing geothermal energy capacity is the problem of limited grid capacity. Nationally, only 65 percent of the country's territory is connected to the grid, most of it in the more developed western islands; while only 45 percent of eastern Indonesia is connected (Jakarta Post, June 2012). Indonesia is currently trying to expand its infrastructure (i.e. transmission systems) with support from the World Bank with a loan of USD 225 million (World Bank 2010a). Without overhauling the grid system, geothermal energy development is likely to remain sub-optimal.

And finally, ignoring the social and environmental impacts can significantly increase the economic costs of geothermal energy development, and may even lead to costly project delays.

Policy and institutional barriers

While Indonesia's government appears to have thrown its full support behind geothermal energy development, a few of its energy policies continue to foster a reliance on fossil fuels. In particular, its policies on energy pricing and subsidies send conflicting signals– subsidies distort the electricity market price, making fossil fuels appear cheaper and therefore preferable to geothermal energy. To accelerate geothermal energy development, comprehensive economic incentives need to be in place, which include further reforming energy tariffs so they reflect true market prices.

It is this lack of clarity around the country's energy policy framework and institutional arrangements (including the bureaucracy, the legal system and tendering process) that discourage investment in the industry. The involvement of different ministerial institutions and agencies in the Indonesian energy sector, for example, creates a significant challenge in terms of coordination.

Another source of confusion, which translates to risk, is the division of power between central and local governments. With decentralization, regional governments play a critical role as the official owners of the steam resource, whereas the central government plays an equally pivotal part providing expertise and underwriting the power purchase agreements (De Wilde 2010). While fine in theory, decentralization seems to have only raised transaction costs. As one Jakarta-based development economist describes it, 'the state bureaucracy has a genius for producing more obstacles or disincentives' (Lacey 2010).

Encouraging provincial and district governments to develop geothermal energy is an enormous challenge, as most have little expertise and a limited understanding of energy scenarios and energy development. Developing WKPs (Wilayah Kerja Pertambangan/ Mining Working Area) is likely to be one of the bigger challenges in realizing geothermal energy development, as the tendering process requires interest, ownership and strong capacity at the local level.

Geothermal energy and forest conservation

Geothermal energy development in Indonesia is unique in the sense that much of the development is likely to take place in the country's remaining important forest areas; up to 42 percent of potential geothermal resources or more than 12 GW are located in protected forest areas (MEMR 2011) and are subject to the recently enacted law on pristine forests, which include stricter conditions under which licenses are issued (Girianna 2009; Satriastanti 2011; *The Jakarta Post* 2011).

With the recent slew of policies supporting fast-tracking geothermal energy development in forest areas, there is an urgency to institute a set of sustainability benchmarks that will mitigate associated impacts and risks, and ensure that geothermal energy development is sustainable.

Financing geothermal energy development

In the wake of the global recession, the past years witnessed a slump in investments in renewable energy. Recent developments suggest however a renewed interest in the sector. There has also been a noticeable increase in public investment in sustainable energy companies, amounting to USD 14.1 billion in 2009, as governments resorted to "green stimulus" to keep their economies afloat (UNEP & New Energy Finance 2010); such interest spell an opportunity for building innovative public-private partnerships to support geothermal energy development in Indonesia, particularly for early stage financing.

Indonesia's energy sector has only recently become a lucrative destination for foreign investment, as it was previously dominated by state owned companies. In 1985, limited private sector participation in the form of independent power producers was allowed in the electricity sector. However PLN remains a monolith, continuing its role as the single biggest buyer, distributor and price negotiator in the market (PwC 2011).

Recognizing the significant investment risks associated with geothermal energy development, in particular during the preliminary phases, the Indonesian government, in collaboration with international partners, implemented the following key measures:

- **Access to government guarantees** – In 2011, the Finance Ministry issued a decree, stipulating government guarantees for geothermal projects that are part of the second phase crash programme, and have reached the construction phase. The Finance Ministry later revised the decree to extend the guarantee during the exploration phase, as the risks associated with exploration are significantly higher than power plant construction and steam field operation. However, the revision, which was issued in August 2011, demanded that project developers secure financing within 48 months after the guarantee was issued or they risk losing it (*Bisnis Indonesia 2011*).

- **Improved reliability of geothermal resource data** – The surveys and advanced explorations are run solely by the Energy ministry's geological agency. The scope and accuracy of the exploration data determine the level of risk that private entities take on once they have won an auction for a working area. However private developers and investors continue to question the quality of surface exploration data.

- **The Indonesian “Fit Fund” and the geothermal exploration mitigation facility** – The ‘Fit Fund’, developed by BAPPENAS and international partners (i.e. development banks) in 2010-2011, is designed to support geothermal energy projects that have won tenders but cannot continue development, as they require a tariff above US 9.7 cents/kWH (Beukering 2012). The Fit Fund pays the difference between the price required by geothermal developers and the current electricity price.

In 2011, the government established a USD 128 million fund, which local governments can access to finance exploration drilling (Castlerock 2010). However, with this model, the risks now lie with the local governments, who will have to repay 100 percent of the loan.

The role of carbon financing

Carbon financing is a useful tool to boost the creditworthiness of a project and helps it to obtain the necessary financing, particularly during the early stage development. It monetizes the advanced sale of emission reductions and either boosts project return, raising the IRR (internal rate of return) to attract investment or enhances project equity value for equity or debt investment (NREL 2011). Carbon finance potentially provides a source of funds that can be utilized to bridge the incremental costs associated with geothermal development in Indonesia and an important option to consider as part of a comprehensive pricing policy.

In its current form, the Clean Development Mechanism is contributing to the gigatonnes gap by providing carbon credits to undeserving projects, thereby flooding the carbon markets with dubious credits and causing carbon prices to plunge to levels that are inadequate to effect a shift to low carbon energy.

Recommendations

To realize and accelerate the development of geothermal energy, this report recommends the following policy, institutional, economic and financial measures:

- Substantive institutional reforms are key issues. Not merely creating a new institution to tackle coordination issue but the most important thing is to provide a clear mandate to which institution that leads the process of geothermal energy acceleration.
- Investments in capacity building at the regional government levels (i.e. provincial, district authorities) and for key proponents of geothermal energy development (e.g. developers) in managing geothermal resources are important, particularly for the energy planning and tendering process.
- Reduce if not completely eliminate subsidies for fossil fuels and provide sufficient capital to support sustainable geothermal energy development.
- To accelerate geothermal energy development, overall economic incentives system needs to be improved, which includes further reforming energy prices so that they reflect true market prices. Geothermal energy prices should be bankable to improve its access to fund and consider project risk, which will be different in each location.
- Reduce exploration and other early stage development risks by improving completeness and reliability of exploration data and implementing risk-mitigation measures.
- Stimulate commercial financial institutions to support renewable energy including geothermal and also formulate financial instruments that can reduce resource risk and accelerate Indonesia's geothermal energy development.


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- Expanding the grid is urgent and critical. Without overhauling the grid system, geothermal energy development is likely to be sub-optimal. In addition to the improvement of the existing grid, the need of local communities to have an access to electricity requires to be seriously addressed.
- With explicit policy support for accelerating geothermal energy development in forest areas, it is imperative that measures are taken so that lands acquired for geothermal energy use are not high conservation value forests or sensitive ecosystems, and that the impacts and risks on forests are mitigated. WWF's Ring of Fire project is currently building, in collaboration with key Indonesian stakeholders, sustainability standards designed to manage environmental and socio-cultural impacts and ensure the sustainability of geothermal energy development.
- The proponents of geothermal energy development (e.g. investors, developers and the government) should anticipate and mitigate the social and environmental impacts of geothermal projects, as these can significantly increase the economic costs of development, and may even lead to costly delays.
- In particular, the development of different strategies is needed to lower the transaction costs of Indonesia's decentralised governance arrangements around energy investment and regulation. To reduce transaction costs should not be confused as an argument for deregulation, but should rather be seen as a call for the removal of uncertainties around regulatory decisions already taken and their replacement by efficient executive motors of implementation.

1. INTRODUCTION

Indonesia, Southeast Asia's largest energy producer and consumer, boasts enormous renewable energy potential and yet little progress has been made in increasing renewable energy usage.

To date, government energy policies continue to foster a reliance on fossil fuels. This archipelagic nation of more than 220 million people predominantly uses coal to meet its electricity demand, which rises at a staggering 9 percent each year (Ardiansyah 2011; PwC [PricewaterhouseCoopers] 2011); after coal, oil and gas are the main energy sources fuelling the country's economy. On the other hand, only 4.2 percent of 28 gigawatts (GW) of potential geothermal resources – larger than in any other country – had been tapped by 2010 (Alfian 2010b; Sukhyar 2011). With energy demand only expected to rise further, experts foresee that in the immediate future Indonesia's energy path will continue to rely heavily on its coal and gas reserves (Leitmann et al. 2009; World Bank 2009).

1. Introduction

However Indonesia's dependency on fossil fuels leaves two undesired consequences– a strained government budget while also undermining the country's climate change mitigation efforts. The fuel subsidy – developed during the Soeharto regime to ensure the availability of cheap energy – has turned into a huge fiscal burden for the state, amounting to nearly 21 percent of total government expenditure in 2005, and continues to rise (Resosudarmo et al. 2010). The increase in the use of fossil fuels is also projected to raise Indonesia's greenhouse gas (GHG) emissions fourfold by 2030 (Fiscal Policy Office 2011). This growth in emissions is in contradiction of the commitments made by Indonesia's President to reduce GHG emissions by 26 percent by 2020[1] and to increase the use of renewable energy so that it accounts for 25 percent of total energy production by 2025 (Fadillah 2011; President of the Republic of Indonesia 2011; The Secretary of the Cabinet of the Republic of Indonesia 2011).

Research shows that renewable energy sources can meet up to 35 percent of Indonesia's energy needs by 2035[2] (Leitmann et al. 2009; Marpaung et al. 2012). Geothermal power in particular can play a key role in shaping Indonesia's low carbon future, with the potential to replace coal-fired power plants as a base load electricity source with virtually no emissions (Mackay 2008). The challenge lies in making this transition within the country's existing institutional structures under which the price of fossil fuels is not only heavily subsidized but also centrally set (Ardiansyah et al. 2012).

[1] As stipulated in Presidential Decree No. 61 of 2011 on National Action Plan for the Reduction of Greenhouse Gas Emissions (RAN GRK [Rencana Aksi Nasional Penurunan Emisi Gas Rumah Kaca]).

[2] At the 2nd Congress of the East Asian Association of Environmental and Resource Economics, in Bandung, Indonesia, Marpaung et al. (2012) presented an AIM/End-use model developed to examine the energy security implications of a renewable portfolio standard (RPS) in Indonesia. In their model, three levels of RPS are considered–15 percent, 25 percent, and 35 percent– within the planning horizon 2005 to 2035 (Marpaung et al. 2012).

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This report provides a comprehensive and insightful assessment of Indonesia's energy dilemma, while also outlining the roadmap for increasing geothermal energy's share in the country's energy mix. Section 2 of this report discusses the unwanted implications for energy security, energy poverty and climate change mitigation, if Indonesia were to continue its dependency on fossil fuels. Section 3 presents the argument that Indonesia's geothermal resources are abundant and exploitation of this energy resource is technically feasible and sustainable. Section 4 enumerates geothermal energy's positive economic impacts as it relates to energy security, government revenue, employment, and carbon dioxide (CO_2) emissions reduction, as well as the risks and costs inherent in exploiting this type of energy. Section 5 looks at the bureaucratic challenges that come with an evolving energy policy framework and opaque institutional arrangements. The section also explores the opportunities and roadblocks created by decentralization in scaling up geothermal energy development. Section 6 confronts yet another growing challenge, that of identifying the balance between geothermal energy development and forest protection. It has been estimated that up to 42 percent of the potential geothermal resources or more than 12 gigawatts (GW) are located in protected forest areas (MEMR 2011) and therefore subject to the recently enacted (and stricter) law on pristine forests (Girianna 2009).

Section 7 looks at the investment climate for renewable energy and discusses various financial incentives that can help reduce the risks in geothermal energy development.

Section 8 presents a mix of policy and economic strategies to accelerate the development of geothermal energy, which are sensitive to constraints imposed by Indonesia's institutions, economic structures and politics.

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2. The folly of fossil fuels

2.1. Indonesia's energy security challenge

Indonesia's dependence on oil imports to fuel its economy is no longer economically viable. The country's energy mix has historically been heavily dependent on oil; in 2010, oil's share in the national energy mix was at 47 percent (Ministry of Energy and Mineral Resources, 2011). Soaring global oil prices reaching USD 113.61 per barrel in June 2011 have placed considerable strain on the Indonesian economy (EIA 2011). The state budget is burdened by heavy oil and electricity subsidies , which were estimated at USD 9.78 billion in 2010 and USD 3.68 billion as of March 2011 (Agustina et al. 2008, Kertiyasa 2011, Suharmoko 2010). According to the Ministry of Finance, energy subsidies in 2012 have reached USD 18.55 billion[4], 17 percent of total government expenditures. Figure 1 illustrates the trend of Indonesia's energy subsidies.

Under the Soeharto government, which was anxious to maintain social stability, there was an emphasis not only on food but energy security[5]. The central government subsidised the price of a variety of energy products, including electricity, to ensure energy was affordable and available (Agustina et al. 2008: 12). As long as the price of oil was low and the value of the rupiah relatively high, the subsidies remained modest.

[4] This calculation is underestimated: the assumption used in the 2012 budget is only USD 90 per barrel of oil (Rachmawati & Suprihadi 2012).

[5] Energy security is conventionally defined as assured access to cheap energy, or, in the jargon of energy analysts: 'availability, accessibility, affordability and acceptability'. In more specific terms, this means the provision of affordable, reliable, diverse, and ample supplies of oil and gas and their equivalents (Kalicki & Goldwin 2005).

However, the Asian financial crisis of 1997 resulted in a substantial fall in the value of the rupiah even as the price of crude oil rose considerably in early 2000. Fuel subsidies increased markedly from 1998 to 2000 following the sharp depreciation of the rupiah relative to the US dollar, peaking in 2000 and accounting for 28.6 percent of total spending (Agustina et al. 2008). In 2008, government funds allocated to energy subsidies reached USD 29 billion or Rp 268.7 trillion[6] (Rp180.3 trillion for fuel subsidies and Rp88.4 trillion for electricity subsidies), accounting for nearly 25 percent of total government expenditures and deterring capital investment in the sector (Haeni et al. 2008).

Energy subsidies bring a substantial number of perverse economic impacts. While intended to help the poor afford fuel, for example, it is the rich who benefit from it disproportionately (Pallone 2009). The Coordinating Ministry for Economic Affairs admitted in 2008 that indiscriminate fuel subsidies have been a poor way to target welfare transfers, with the wealthiest 40 percent of households capturing 70 percent of the subsidies (Beaton & Lontoh 2010). Moreover:

> "subsidies tend to cause overconsumption of the resource, since the market price does not reflect the actual cost of producing one unit of petroleum product. They also discourage energy efficiency measures and the development of alternative or renewable energy sources by way of low electricity tariffs. The state budget is heavily burdened by this policy and in order to provide low-priced electricity, they are denying access to nearly half the population. This policy mostly favours the urban population or those who are privileged enough to have access to electricity while forgoing the development of necessary new infrastructure needed to deliver electricity to those without it" (Resosudarmo et al. 2010).

The Indonesian government has attempted to reform its fossil-fuel subsidies a number of times the past ten years[7], pursuing various strategies to lessen the country's reliance on fossil fuels, including reducing subsidies to Pertamina (a state-owned oil and gas company), the electricity sector, and for petroleum products (Beaton & Lontoh 2010). While there has been partial success, subsidies remain a politically contentious issue.

[6] This amount of energy subsidy was calculated to be around 4 percent of Indonesia's gross domestic product (GDP) (Haeni et al. 2008).

[7] For Indonesia's attempts to reform fossil-fuel subsidies see Beaton and Lontoh (2010).

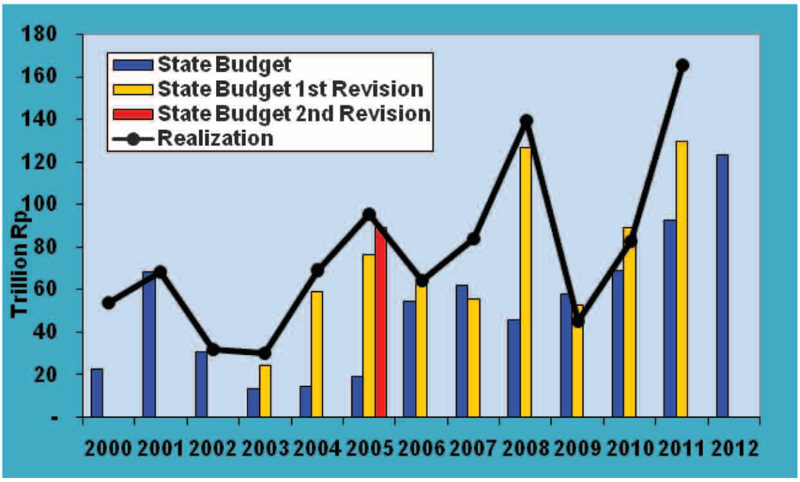


Figure 1: Fuel Subsidies in the Central Government Budget and Realization. Source: Ministry of Finance, 2000 - 2012

Meeting the country's growing electricity needs has also taxed Indonesia's domestic oil reserves. With a production capacity of 0.5 billion barrels per year, it is estimated that Indonesia's remaining 10 billion barrels of oil reserves will be exhausted in 20 years time (ESDM 2012; Koalisi Energi 2005). In 2011, oil reserves were estimated at around 7.7 billion barrels of which 4.04 billion were proven reserves (Ministry of Energy and Mineral Resources. 2012). Should no new reserves be found, Indonesia is projected to become a significant oil-importing country in less than two decades. Since 2004, the country has already been a net importer of both crude oil and refined products (Sa'ad 2009).

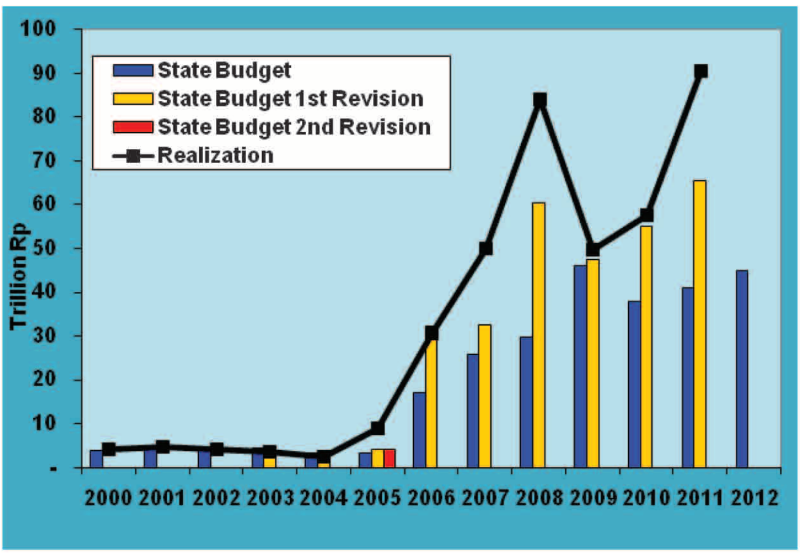


Figure 2: Electricity Subsidies in the Central Government Budget and Realization. Source: Ministry of Finance, 2000 - 2012

Box A: Wasting what little there is

To make matters worse, Indonesia's levels of energy elasticity and intensity fall into the category of 'consumptive' or 'close to wasteful'. The energy elasticity figures for Indonesia (1.04-1.35) for the period 1985 until 2000 (Koalisi Energi 2005) are high when compared with corresponding figures for developed countries (0.55-0.65). A 2008 report for the USAID pegged Indonesia's energy elasticity to 1.8, while Energy Efficiency and Conservation Clearing House Indonesia (EECCHI) revealed that in 2009 the figure was as high as 2.69 (EECCHI 2011; Haeni et al. 2008). The International Energy Agency reported that in 2009 the energy elasticity in Thailand was 1.4, Singapore 1.1 and developed countries 0.1-0.6 (EECCHI 2011). With regard to energy intensity, the figure of Indonesia (index, 500) is five times that of Japan (index, 100) and higher than that of North America (index, ~300), Organization for Economic Co-operation and Development (OECD) countries (index, ~200), and even Thailand (index, ~350) (Koalisi Energi 2005). In 2008, it is also reported that the energy intensity of Indonesia's economy surpassed most Asian countries (Haeni et al. 2008). And in 2009, this figure increased to 565, while energy intensity for Malaysia and developed countries were 439 and 164 respectively (EECCHI 2011).

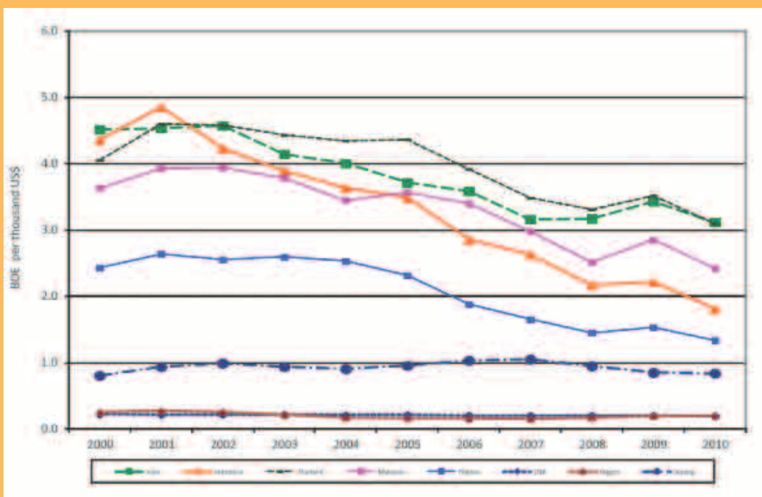


Figure 3: Comparison of Primary Energy Intensity in Some Country
Sources: Handbook of Energy and Economic Statistics of Indonesia

2.2. Energy poverty and development

Indonesia's steady economic growth of more than 6 percent, even during the recent global recession, was accompanied by a 9 percent growth in electricity demand each year (Ministry of Finance 2009; PwC 2011). The country however struggles to meet this demand. A significant number of Indonesia's population, primarily those living in rural areas and the outer islands[10], lack access to electricity; several reports estimate this to be around 60-80 million people, or almost a third of Indonesia's 225 million inhabitants (*Asian Trends Monitoring 2010*; Barbotte 2010; Ministry of Finance 2009). Electrification ratio was 58.3 percent in 2005 and increased to 72 percent in 2011 (PLN, 2012). In 2010, the government set a target electrification ratio of 91 percent by 2019 (PLN 2010).

To meet the country's increasing electricity demand and electrification target is a formidable task for its existing energy infrastructure; of all 26 main electrical systems, a total of 15 systems faced serious supply deficits in 2010, where brownouts could not be avoided, thereby affecting major economic centers in Sumatra and Sulawesi (*Jakarta Update 2010*). The weak growth in electricity supply over the years resulted in a "crisis condition"[11] (*Jakarta Update 2010*), where PLN (Perusahan Listrik Negara [the state-owned electricity company]) was forced to enact rotating blackouts, even in the capital city of Jakarta.

To address the supply-demand gap, the central government initiated a 'crash programme' that brought 10,000 MW of coal-fired power plants online, as stipulated in Presidential Decree No. 71 Year 2006 (Leitmann et al. 2009). While the coal-fired power plants alleviated short-term supply problems, as well as reduced dependency on increasingly expensive imported oil, the approach failed to address energy security goals. Interview data revealed that the plants– purchased at low cost from China– were mostly dirty and inefficient (Ardiansyah 2012).

A second-phase crash programme, to be implemented between 2009 and 2018, at an estimated cost of USD 21.3 billion (ESDM 2009b), will source 60 percent of new capacity from renewable resources. At least 5,000 MW or 48 percent will be sourced from geothermal resources (Ardiansyah et al. 2012; Girianna 2009), which can help increase access to electricity in the outer islands where most geothermal resources are located (Girianna 2009). It is crucial to note, however, that building geothermal power plants in remote areas requires additional financing to connect electricity production to the main grid (Tanoto & Wijaya 2011).

[10] Development of generation and grid capacity in remote islands and rural areas is often viewed as not economically viable or attractive.

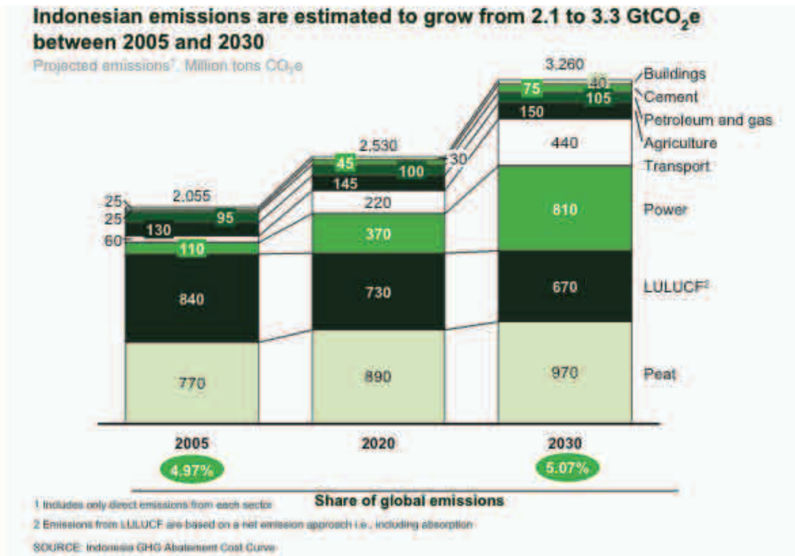
[11] Crisis condition refers to a situation where the electricity supply capacity is lower than the demand/electric load and there is no new generation in the system within the next two years (Jakarta Update 2010).

2.3. Energy sector emissions and climate change mitigation

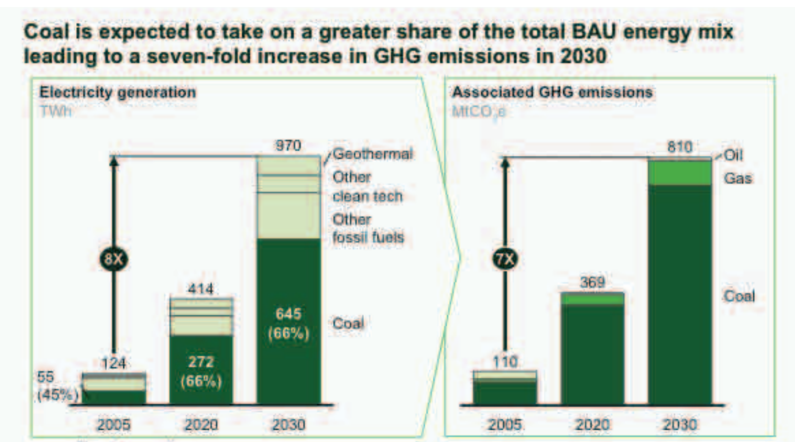
While providing short-term relief from supply shortages, the use of coal as the main energy resource in Indonesia's second crash programmes casts a shadow on the country's commitment to tackle climate change[12] (Ardiansyah 2011; National Energy Foundation 2001).

Although more than 90 percent of Indonesia's current GHG emissions are from forestry and land-use sectors, experts predict increased CO_2 emissions from electricity generation by 2030, reaching 810 million tonnes of CO_2 equivalent (CO_2e), due to heavy dependence on coal (see Figure 4A and 4B). This increase of nearly seven times the amount in 2005 (DNPI 2010) will exacerbate climate change impacts to which Indonesia, an archipelagic nation, is already vulnerable to (Ministry of Environment 2009).

[12] The negative impacts of coal use, however, go beyond increased GHG emissions. Coal contributes to local pollution such as smog and acid rain (Ardiansyah 2010; National Energy Foundation 2001). The sulphur in coal combines with oxygen to form sulphur dioxide, which can be a major source of air pollution if emitted in large enough quantities (National Energy Foundation 2011).



(A)



(B)

Figure 4: **(A) Indonesia's projected emissions 2005-2030 in mtCO$_2$e** (source: DNPI 2010);
(B) Projected emissions rise from coal use under Business as Usual (BAU) in 2030 (source: DNPI 2010)

Conversely, the development and use of geothermal energy could reduce GHG emissions, as described in a 2011 study (Tanoto & Wijaya 2011) comparing two different energy scenarios (see Figure 5). In scenario A, coal is the foundation of Indonesia's electricity generation mix: In 2008, coal takes 44 percent of the total power generation share, or about 10.5 GW, followed by natural gas with 9.8 GW (41 percent). By 2027, coal's share grows to 75.4 GW (57 percent), while the share of natural gas shrinks to 52.7 GW (39 percent) (Tanoto & Wijaya 2011). In scenario B, the model aims at enlarging geothermal energy's share in the power generation mix; in 2027, the installed capacity from geothermal sources will reach 7 GW (a significant growth from only 1.2 GW in the base year) (Tanoto & Wijaya 2011). The increasing share of geothermal in scenario B reduces the use of coal: by 2027, coal use shrinks to 67.6 GW or 51 percent of total electricity generation mix (Tanoto & Wijaya 2011).

Figure 5: (A) The electricity generation mix of the first scenario – coal is the main source (source: Tanoto & Wijaya 2011); **(B) The electricity generation mix of the second scenario – coal is still the main source but geothermal input is increased** (source: Tanoto & Wijaya 2011)

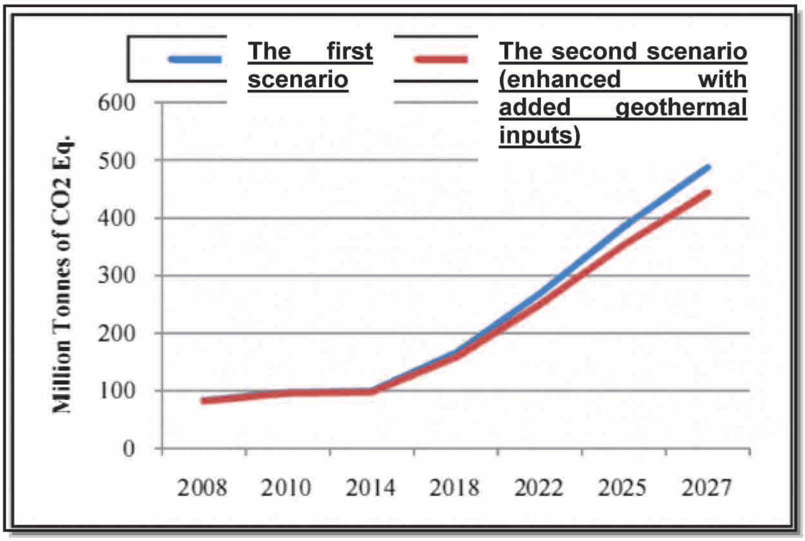


Figure 6: Environmental emissions of coal and geothermal scenarios (source: Tanoto & Wijaya 2011)

Comparing energy utilization scenarios A and B reveal that as early as year 2014 emissions from scenario B (which have increased geothermal capacity) will begin to decline (Tanoto & Wijaya 2011). Figure 6 shows that at the end of the planning horizon, scenario A emits as much as 487 million tonnes of CO_2e, while scenario B will have reduced emissions by 43.3 million tonnes (Tanoto & Wijaya 2011). Energy scenarios developed by the Ministry of Energy and Mineral Resources (MEMR) exhibit similar patterns (see Figure 7); in 2011, emissions from the geothermal scenario (where geothermal energy's capacity reached 27 GW or 8.4 percent of the national energy mix), decline in comparison to emissions from the business-as-usual scenario (Ariati 2009).

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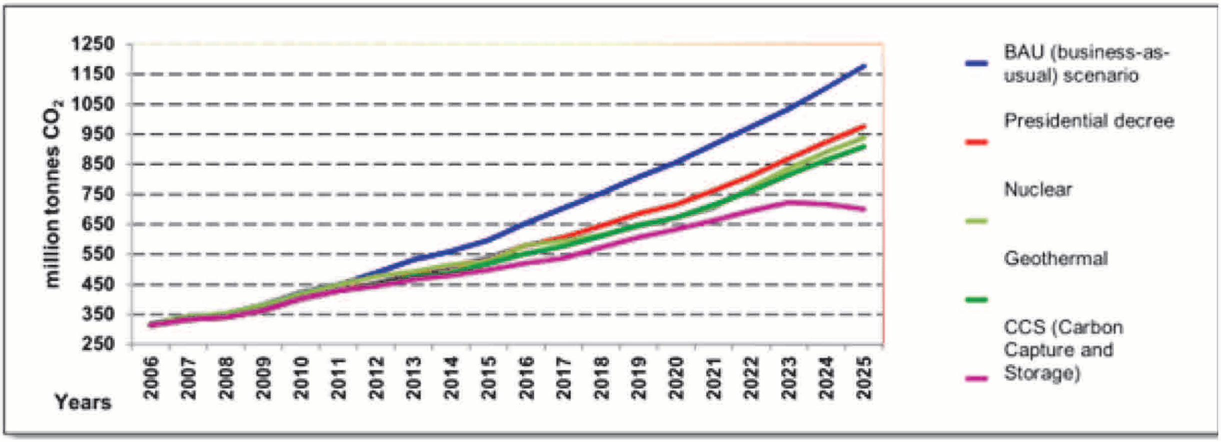

Figure 7: **MEMR CO_2 emissions reduction scenarios for the energy sector** (source: Ariati 2009)

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3. Geothermal energy in Indonesia

3.1. Indonesia's geothermal wealth

After the first study was made of Java's active volcanoes and hydrothermal areas in 1854, it was the Dutch Colonial Geological Survey (DCGS) in the early part of the 20th century that mapped some of Indonesia's Quaternary volcanoes, Fumaroles and Solfatara fields (Hochstein & Sudarman 2008). In 1969, after a long period of inactivity following the country's independence in 1945, the Geological Survey of Indonesia (GSI) began work on reconnaissance surveys with support from international aid agencies.
In 1974, the Vulcanological Survey of Indonesia (VSI) in cooperation with the PLN conducted geological mapping and testing. In 1981, a presidential decree was issued allowing Pertamina to enter into joint operation contracts (JOC) with companies looking to invest in geothermal resources, active volcanoes and hydrothermal areas, an operating framework that has since been replaced by the Geothermal Law of 2003.

By mid-1980s about 70 potential high temperature geothermal sites had been identified and investigation of these sites using geological methods reduced the number to 15 productive sites; by 1995, three of these fields were developed to supply steam to run power plants with a total capacity of 305 MWe, and by 2000, the total capacity reached 800 MWe in six fields (Hochstein & Sudarman 2008). In 2010, two large geothermal projects, the Darajat-3 and the Kamojang-4 plants near western Java, were approved for funding and construction (IEA 2010). The Indonesian government plans to build 4,000 MW of geothermal power capacity by 2015 with a longer-term target of 9,500 MW by 2025 (Sanyal et al. 2011). Table 1 presents Indonesian geothermal potential and reserves as of December 2010.

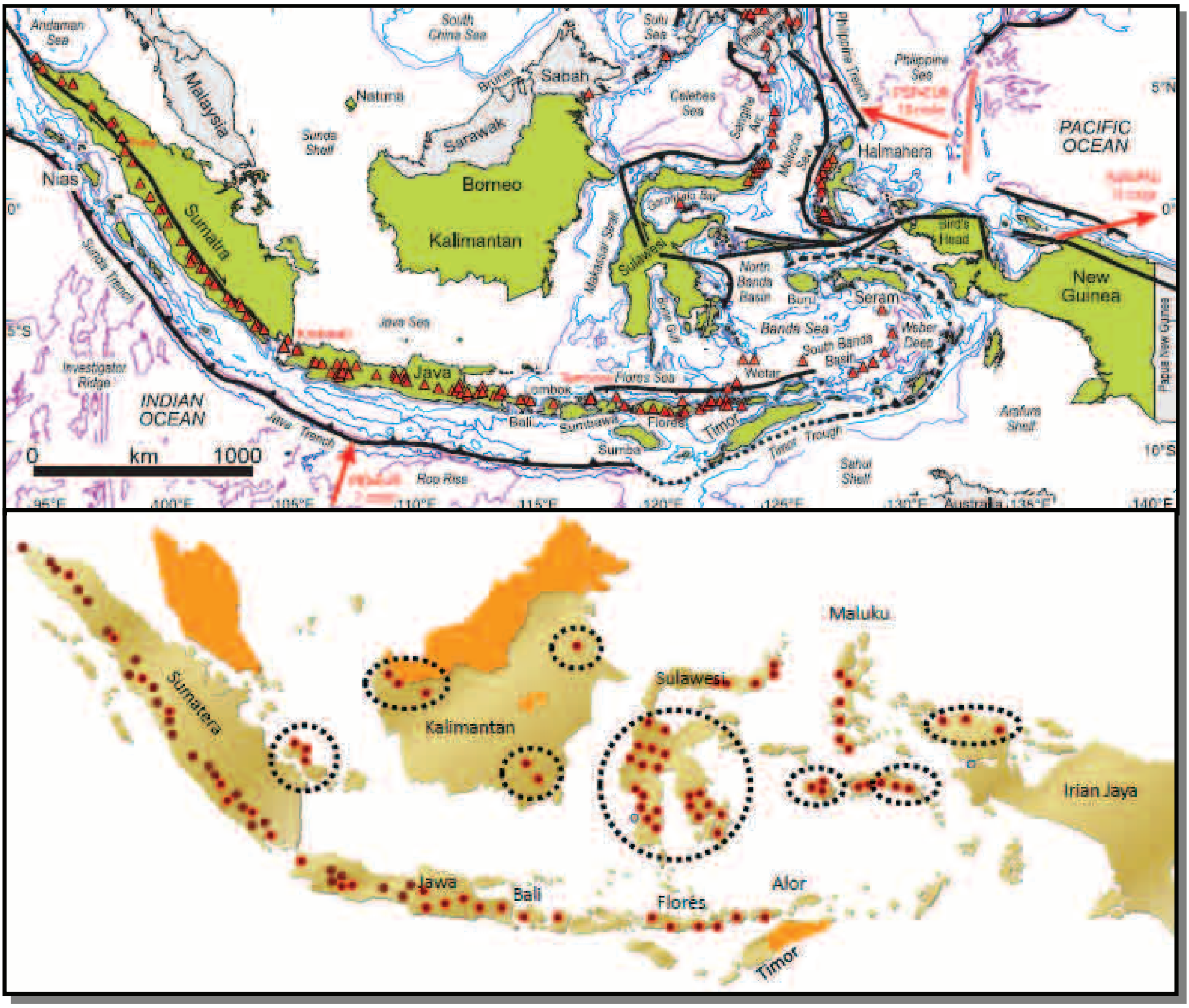

Figure 8: **(A) Geology of Indonesia** (source: Hall 2007); **(B) The distribution of geothermal areas in Indonesia** (source: Sukhyar 2011). **Notes: 276 geothermal areas and 28.99 GW of potential geothermal resources. is the symbol for non-volcanic geothermal.**

Box B: Why Indonesia simmers

The Indonesian archipelago is located in one of the most tectonically active regions in the world, nestled near the boundaries of the Indo-Australian, Pacific, Philippine and Eurasian tectonic plates. It is the region's unique geological complexity that is responsible for its dynamic geothermal activity. Figure 8A shows Indonesia's major plate boundaries, the relative movements of plates, the major fault systems and volcanoes; Figure 8B illustrates the distribution of geothermal areas across the country.

In addition to the heat transfer within the earth's crust from latent heat formation and radioactive decay, heat is also transferred towards the surface from cooling magmatic intrusions and extrusions. The heat flow rate is then increased by convection of meteoric water. Convective hydrothermal systems of high and low temperatures are abundant in Indonesia, particularly in the island of Sumatra, and are considered easily accessible because they form at shallow depths of 1.5 to 2km, which makes development of this type first priority. Hot-dry rock systems also have potential for electricity generation, but the technology needed to utilize these systems is not as established compared to hydrothermal systems. (See Annex B for discussion on different geothermal energy technologies.)

Table 1: Indonesia geothermal resources potential reserves and installed capacity (source: Sukhyar 2011)

Islands	Potential resources (megawatts-electrical [MWe])		Reserves (MWe)			Installed capacity (MWe)
	Speculative	Hypothetical	Possible	Probable	Proven	
Sumatra	4,785	2,281	5,925	15	380	12
Java	1,935	1,836	3,848	658	1,815	1,124
Bali and Nusa Tenggara	410	359	983	-	15	-
Kalimantan	115	-	-	-	-	-
Sulawesi	929	342	1,115	150	78	60
Maluku	535	43	371	-	-	-
Papua	75	-	-	-	-	-
Total geothermal areas = 276	9,210	4,861	12,242	823	2,288	1,196
	13,641		15,353			
	28,994					

Of all 276 geothermal areas in Indonesia, a total of 37 can be considered "mining working areas", commonly referred to as WKP (*Wilayah Kerja Pertambangan*) (Sukhyar 2011). A summary of the 37 WKPs is provided in Table 2, although not all sites have been successfully auctioned off. What is clear from Table 2 is that the government can easily meet its geothermal energy targets by focusing on WKPs that are mature and ready; in this respect, developing Pertamina's fields can be made a priority (Sukhyar 2011).

It is crucial to note that the quality of surface exploration data produced by the Indonesian government, notably the geological unit of the Ministry for Energy and Mineral Resources (MEMR), has been criticized as inadequate by private developers and investors.

Information such as credible estimation of the depth and size of resource, the heat source location and upflow and outflow zones, the capacity of recharge and discharge zones as well as possible permeable targets for drilling is critical and largely missing from government survey data. The Geological Agency, also under the MEMR, identified 265 geothermal locations across the archipelago, however only about 30 percent has been surveyed in detail (Wahjosoedibjo & Hasan 2012).

Table 2: Summary of geothermal WKPs (source: Sukhyar 2011)

WKP	Number of WKPs	Geothermal potentials (MW)	Installed capacity (MW)
Pertamina[14] (JOC [joint operating contracts] and own operations)	15	~5,000	1,189*)
WKP – auctions completed**)	6	335	-
WKP – currently being auctioned	5	965	-
WKP – ready for auctions	11	1,076	-
Total	**37**	**7,376**	**1,189**

Notes:
*This installed capacity is a result of old policies (prior to Law No. 27 of 2003 on Geothermal) **Five WKPs have obtained IUP (Izin Usaha Pertambangan Panas Bumi [Geothermal Energy Business Permit])

3.2. Existing steam fields and power plants

Geothermal development in Indonesia is concentrated mostly in Java-Bali, Sumatra, and North Sulawesi, due to a growing demand for electricity and adequate infrastructure in these areas (Hutapea & Lestari 2010). Table 3 presents a summary of existing geothermal plants. Early studies conducted by a New Zealand research group in Indonesia saw immense potential for electricity production from five fields, four of which were located on the island of Java, namely Gunung Salak, Kamojang, Darajat and Cisolok (Hochstein & Sudarman 2008). Gunung Salak is the fourth largest geothermal power generation plant in the world, with an output of 377MW (see Box C for case study). The experience gained from the operation of power plants at Gunung Salak, Kamojang, Darajat, Dieng and Wayang Windu has helped advance the knowledge of reservoir management and reinjection strategies in geothermal power generation (Suryadarma et al. 2010).

[14] Pertamina (Perusahan Tambang dan Minyak Negara) is Indonesia's state-owned oil and gas company. For the company's full profile, see on: 'Company profile', Pertamina.com, viewed 12 August 2011, at <http://www.pertamina.com/index.php/home/read/company_profile>.

Geothermal prospects outside Java have not been pursued as enthusiastically, and the type of reservoir may be an important factor, as seen in the dominance of liquid-based geothermal plants in Lahendong on the island of Sulawesi and at Sibayak on the island of Sumatra. (See Annex B for a review of geothermal energy technologies.) Nonetheless significant potential exists in Sulawesi and Sumatra, specifically in fields Sarulla, Ulubelu and Lumut Balai in Sumatra, as well as Kotambagu in Sulawesi (Hutapea & Lestari 2010). The volcanic regions of the Sulawesi islands are estimated to hold massive geothermal reservoirs, crucial to supporting the region's fast growing heavy industries, such as cement and mining. The total estimated geothermal resource in North Sulawesi is 815 MWe. (Sasradipoera & Hantono 2003).

Table 3: Summary of major operating or planned geothermal plants in Indonesia
(source: Hutapea & Lestari 2010)

Power plant	Location	Capacity	Development/	
Construction	Commencement			
Kamojang, Units I, II, III	Java	140 MW	1980s	Unit I: 1982
Unit II & III: 1987				
Darajat I	Java	55 MW	1994	1994
Awibengkok I	Java	3×55 MW		1994 (2 units)
1997 (1 unit)				
Awibengkok II/Salak	Java	3×55 MW	1994	1997
Dieng I	Java	60 MW	1994	1998
Darajat II	Java	90 MW	1997	2000
Wayang Windu	Java	110 MW	1997	2000
Kamojang, Unit IV	Java	60 MW	2006	2007
Darajat III	Java	117 MW		2006
Dieng II	Java	60 MW	Planning phase	2012-2014
Sarulla	Sumatra	3×110 MW	Planning phase	2011
Ulubelu	Sumatra	2×55 MW	Planning phase	2011-2012
Sibayak	Sumatra	11.3 MW	Planning phase	2013
Lahendong I	Sulawesi	20 MW		2001
Lahendong II	Sulawesi	20 MW		2007
Lahendong III	Sulawesi	20 MW		2008

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Box C: Gunung Salak (Awibengkok):

Gunung Salak (Mount Salak) was among the five potential sites proposed for development by the New Zealand geothermal aid programme in 1973 (Hochstein & Sudarman 2008). Explorations conducted between 1973-75 in the region of Gunung Salak hinted at the reservoir being vapor-dominated; however deeper exploratory drilling was not done due to high associated costs and the region's tough terrain.

In 1982, Unocal Geothermal Indonesia undertook more studies in the area with three exploratory wells with depths of 1,370m, 1,710m and 1,830m, which then produced steam reaching temperatures between 260-279oC (Hochstein & Sudarman 2008). The viability of the Gunung Salak field for power generation was confirmed, and plans were put in place to build a power plant. The first three 55MW units came into operation in 1994, with the remaining six units starting commercial operation in 1997. The high capacity factor of all six units (around 95 percent since start up) helped meet the rising demand for electricity in the Java/Bali region (Suryadarma et al. 2010).

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The case for geothermal development and forest conservation

What makes Gunung Salak a unique case study is that the geothermal field is situated in dense primary rainforest (Slamet & Moelyono 2000). The permit to exploit the geothermal resource had been issued prior to the passage of 1999's Law no. 41 on Forestry, which forbids mining exploitation (including geothermal) in forest areas. To address environmental concerns, prior to the construction of the first phase of the Salak project (110 MW) in 1990, an environmental impact assessment (EIA) was carried out in 1989 (Slamet & Moelyono 2000). The second EIA was conducted in early 1994 incorporating the Phase 1 experience and addressed stricter measures to protect the environment (Slamet & Moelyono 2000). Environmental issues identified in the 1989 and 1993 EIA include: (a) a decline in protected forest areas; (b) temporary disturbance to the wildlife habitat, particularly during the exploration and construction activities; (c) increasing surface soil erosion during construction activities; (d) temporary changes in the physical characteristic of stream water quality and sundries (Slamet & Moelyono 2000). The geothermal project developer and operator, in collaboration with the national park's management body, implemented measures to mitigate the environmental impacts, through measures such as minimising forest usage and controlled land clearing (Slamet & Moelyono 200).

In 2003, Gunung Salak was declared an extension of Gunung Halimun National Park, which was later renamed Gunung Halimun-Salak National Park (Taman Nasional Gunung Halimun-Salak [TNGHS]). To date, TNGHS, covering 113,357 hectares, is one of the few national parks with the largest mountainous tropical rainforest ecosystem area in Java Island (Ario 2007).

4. The economic arguments for geothermal energy

Against the backdrop of increasing fossil fuel prices, as well as growing concerns over energy security, renewable energy is well positioned to play a critical role in Indonesia's energy mix. By expanding the use of geothermal energy in particular the government has within its means another tool to better manage its economic future.

4.1. Geothermal energy's economic wins

Energy security

As mentioned in section 2, geothermal energy can help improve the country's energy security[15] as it curbs the need for imported oil in the power sector (and therefore shields the economy from fluctuations in oil prices[16]) (Harsoprayitno 2009a; PwC 2011). Geothermal energy can also play a significant role in addressing Indonesia's energy shortfalls; for example, by 2014, the government's second-phase 'crash program' will have commissioned 3,967 MW of geothermal capacity, approximately 40 percent of the total planned capacity (Castlerock 2010). See Annex C for a full list of the proposed geothermal power plants in the crash programme.

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[15] Based on Presidential Regulation No. 5 of 2006, one of the goals of national energy security is achieving an optimal energy mix by 2025, which includes the decrease in oil (less than 20 percent) and the increase in geothermal and renewable energy to more than 5 percent.

[16] While no study has yet been made of the impacts of fossil fuel price volatility on Indonesian economy, in Europe the macroeconomic cost of the 2000-2004 oil spikes was over 400 billion euros (Awerbuch, 2006).

Emissions savings

Several studies illustrate the significant GHG emissions savings from an increase in geothermal energy utilization (see Figure 9). One such study by Wijaya and Limmeechokchai (2009) shows that an increase of 10 GW in geothermal energy capacity by 2025 will result in emission savings[17] of approximately 58 million tonnes of CO_2e. It is important to note that 10 GW is the total geothermal potential presently ready for commercial extraction (Leitmann et al. 2009). See also section 2.

[17] CO_2 emissions savings are calculated comparing the estimated amount of CO_2 emissions coming from geothermal power plants with coal-fired power plants in the same period with similar installed capacity.

BOX D:
Darajat III - A case study in GHG emissions savings (Amoseas 2004)

Amoseas Indonesia Inc. (Amoseas), under a JOC with Pertamina and an Energy Sales Contract with PLN, expanded operations at Darajat, West Java by installing a 110 MW geothermal power plant (Darajat III). Based on internationally recognized emission factors for GHG emissions from coal combustion and an assumed gross electrical output of 906,000 MWh per year, it was calculated that the actual GHG emissions from the Darajat III plant are 30,000 tonnes CO_2e per year, or about 5.2 percent of the emissions from a coal-fired power plant. Darajat III reduces greenhouse gas emissions by about 780,000 tonnes CO_2e for each year of operation, depending on total electricity production.

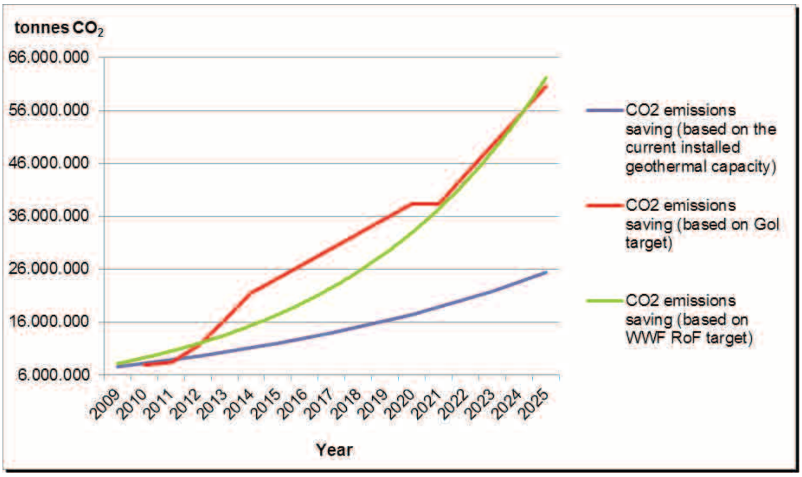

Figure 9: Projection of CO_2 emissions savings based on the current trend of installed geothermal capacity, the Government of Indonesia's target, WWF's Ring of Fire target (source: Authors' calculation using data and figures from Amoseas [2004], Geothermal ITB [2009a] and IEA [2011

Caption: The scenario based on the government's target can achieve an annual reduction of 13.6 million tonnes of CO_2 by 2015 and 17.1 million tonnes of CO_2 by 2020. Alternatively, WWF's Ring of Fire scenario shows an annual reduction of 13.6 million tones of CO_2 by 2015 and 19.8 million tones of CO_2 by 2020. These figures are conservative estimates[18]. [19]

Government revenue

Geothermal energy development and operations are a major source of revenue for the government. According to Law No. 33 of 2004 on Central and Local Fiscal Balance, the percentages of revenue sharing from geothermal tax and royalties are broken down as follows: 20 percent to the central government, 16 percent to the province, and 32 percent each to originating district/municipal governments and other district/municipal governments in the same province (Murniasih 2010).

[18] In its original document, WWF's Ring of Fire estimates an annual reduction of 43.2 million tonnes of CO_2 by 2015 and 70.9 million tonnes of CO_2 by 2020 compared to a coal-based scenario.

[19] The figure used to calculate CO_2 emissions of coal-fired power plants derives from Amoseas (2004), which used the estimate provided by the US Department of Energy (0.894 tonne CO_2/MWh)– more conservative than the IPCC emissions factors of 26.2 kg carbon per GJ of fuel energy input for sub-bituminous coal and where plant thermal efficiency is assumed to be 36 percent (typical for a new coal plant in Indonesia) giving a CO_2 emission factor of 0.961 tonnes of CO_2 per MWh of gross plant output.

Employment

In the United States, building a 50 MW geothermal power plant can create several hundred temporary (two to three year contract) jobs in construction and between 30 to 50 permanent, highly skilled full-time jobs at the facility that pay well above minimum wage (National Geothermal Collaborative 2004). Considering the economic multiplier effect, this should mean approximately 90 to 150 new full-time jobs in the community (National Geothermal Collaborative 2004). In the case of Indonesia, geothermal energy could create as many as one million jobs – significantly more than other types of power generation (McInnis et al. 2010). Using data from National Geothermal Collaborative (2004) and Shibaki (2003), Figure 10 shows estimates of jobs creation from different geothermal energy scenarios, as many as 37,000-206,000 by 2015 and 61,000-325,000 by 2020.

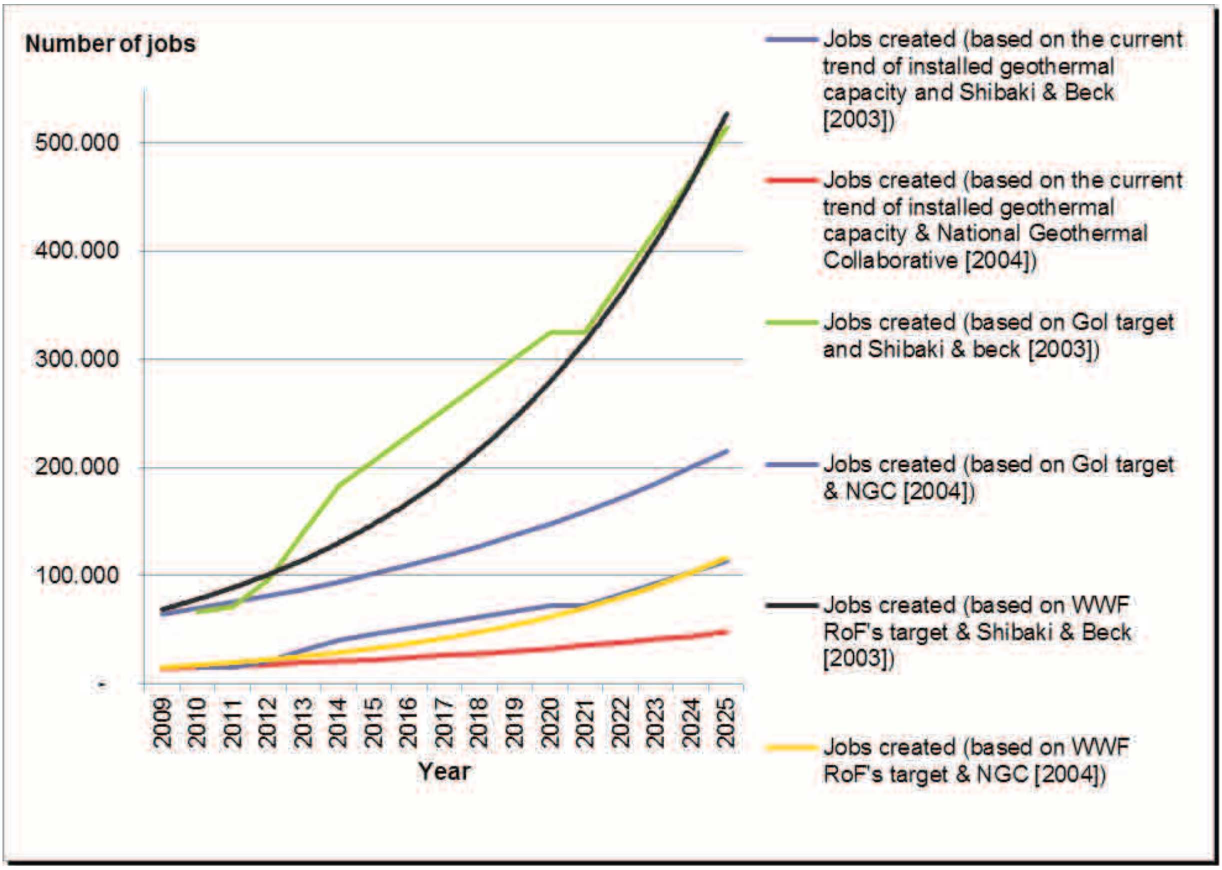

Figure 10: Estimated jobs creation (source: Authors' calculation based on National Geothermal Collaborative [2004] and Shibaki & Beck [2003])[20]

[20] Based on Shibaki and Beck (2003), 27,050 jobs will be created per 500 MW geothermal power plants developed. Based on National Geothermal Collaborative (2004), approximately 600 jobs (400 jobs during construction phase, 50 highly-skilled jobs, 150 jobs in the surrounding communities) will be created.

4.2. Risks and costs of geothermal energy development

Yet to accelerate the development of geothermal energy is somewhat of a herculean task for a developing country like Indonesia. In 2010, a review commissioned by the MEMR argued that it is difficult to meet the official government target[21] of building 3,967 MW of geothermal capacity by 2014, and that the most the government can hope to deliver is 2,297 MW (Castlerock 2010). A World Bank report predicted similar lower figures: only 2,800 MW of geothermal energy capacity would be installed by 2020 (World Bank 2008).

[21] The official government target is the target set by the government and stipulated in its policy or regulation

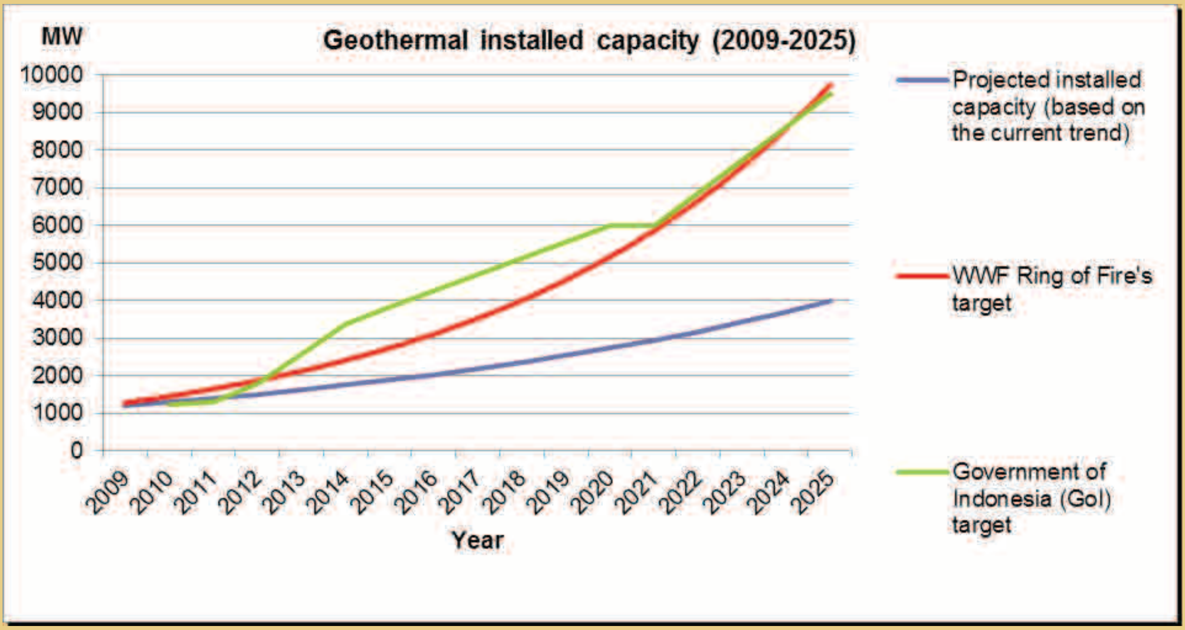

Figure 11: Projection of geothermal installed capacity
(source: Authors' calculation based on various sources)

BOX E:
Reality bites - Projected installed capacity vs targets

Figure 11 shows that, based on current trends, Indonesia can build around 1,700 MW of geothermal capacity by 2014, 2,750 MW by 2020 and only 4,000 MW by 2025. These projected figures are much lower than the Government of Indonesia's target of 6,000 MW by 2020 and 9,500 MW by 2025 (Geothermal ITB 2009a). The projected figures are also lower than WWF's Ring of Fire targets, which increase geothermal electricity generation by 156 percent by 2015 (based on 2009 installed capacity) and 321 percent by 2020. By comparison, the projected figures indicate a mere 57 percent increase by 2015 and 129 percent by 2020.

Pricing

The country's geothermal resources have been underutilized partly due to pricing disagreements between the PLN and the government. Even when geothermal licenses were granted, developers delayed exploration, waiting for power-purchasing agreements with the PLN that were in turn on hold in anticipation of government's pricing approval.[22] As a temporary measure to resolve tariff discrepancies, the PLN introduced in January 2011 an 18 percent tariff hike ceiling, in line with the MEMR's Regulation No. 7 of 2010.

Indonesia's feed-in regulation brings a significantly higher tariff for geothermal power at US 9.7 cents/kWh, although the scope is limited to geothermal fields included in the second-phase crash programme. And even then some developers find the tariff inadequate[23]. In 2010, PT Star Energy Halmahera proposed a purchasing price of 17 cents/kWh and has been in negotiation with the PLN since. The feed-in regulation does allow for establishing a higher price, however this requires prior approval from the MEMR.

To accelerate geothermal energy development, comprehensive economic incentives need to be in place, which include further reforming energy tariffs so that they reflect true market prices. However price increases will not eliminate all risks associated with the electricity market. Castano (2011) reported that some investors remain concerned about the ability of debt-ridden PLN to pay higher tariffs as state coffers are already burdened with high subsidies for the energy sector. A World Bank study found that a power purchase cost that exceeds US 4.95 cents/kWh is likely to lead to further financial losses for PLN regardless of power source, given their current energy mix and retail electricity tariff levels (referred to as the PLN 'benchmark price' or 'breakeven price', this is the level at which PLN can purchase power without incurring additional financial losses) (World Bank, 2008). In the following section, we discuss the challenges with PLN.

[22] Exploration rights were granted as follows: the Jaboi field in Aceh was awarded to a consortium led by PT Bukaka Teknik Utama; the Sorik Marapi field in North Sumatera to a consortium of Tata Power and Origin Energy; the Muara Laboh field in West Sumatera and the Gunung Rajabasa field in Lampung to PT Supreme Energy; the Jailolo field in Halmahera to Star Energy; the Sokoria field in Flores Island to Bakrie Power; the Tangkuban Parahu field in West Java to PT Indonesia Power; the Cisolok field in West Java to PT Rekayasa Industri; the Tampomas field in West Java to PT Wijaya Karya; and the Ungaran field in Central Java to PT Golden Spike Energy Indonesia; see on: Alfian 2010, 'Indonesia geothermal program hung up on PLN pricing delay', *The Jakarta Post*, 22 October, viewed 16 March 2011, at <http://www.thejakartapost.com/news/2010/10/22/indonesia-geothermal-program-hung-pln-pricing-delay.html>.

[23] In 2011, the Indonesian tariff was lower than in the U.S. where developers are paid USD 0.10 to USD 0.12 per kWh (Castano 2011). Also, the Indonesian tariff is lower than in other developing countries including Turkey and the Philippines where developers are paid USD 0.105 and USD 0.148 per kWh respectively (Think Geoenergy 2010; Think Geoenergy 2011).

Development costs

Another immediate risk is related to the costs of exploration. In geothermal energy development, a drilling project exploring a single location can easily swallow EUR 15-20 million (KfW 2011), which does not even take into account the costs associated with the risk of non-discovery (KfW 2011). It can then take another ten years to develop a geothermal power plant to the level of commercial operation with project financing available only in the latter phase of this process (PwC 2011). The fact that geothermal development often requires significant up-front equity is a key issue for investors (PwC 2011).

The accepted wisdom is that geothermal technology is still prohibitive, costing an estimated USD 800 million for a 333 MW power plant (around USD 2.4 million/MW[24]), which places this beyond the financing capability of the Indonesian government. Recognizing the high risks of investment and initial development costs in geothermal resources, the World Bank announced a USD 400 million commitment from their Clean Technology Fund in early 2010 (*Geothermal Digest 2010*), with the purpose of doubling Indonesia's geothermal energy capacity (Padden 2010). The World Bank, Asian Development Bank (ADB)[25] and Japan International Cooperation Agency (JICA)[26] have also jointly financed the Lahendong Geothermal Plant.

In March 2008, JICA undertook a study on fiscal incentives Indonesia needs to accelerate geothermal energy development, such as official development assistance (ODA) finance for Pertamina and an increase in purchase price for private investors to exploit the most promising geothermal fields. The study also emphasised the government's role in developing small geothermal energy resources in remote islands in the eastern regions, as private sector's interest in these locations is unlikely (Alfian & Nurhayati 2010; JICA 2008).

Apart from financial support, further actions recommended by Leitmann et al. (2009) are as follows:

- Introduce risk mitigation mechanisms to reduce high initial costs in exploration;
- Improve government planning and management capabilities, particularly at district and provincial level;
- Build up adequate domestic technical capabilities to support long-term growth in the sector.

[24] Also, Shibaki and Beck (2003) estimated around USD 1.9 million/MW for geothermal power direct capital costs (installed capacity).

[25] ADB financed the plant as one of 12 subprojects under its Renewable Energy Development Sector (REDS) Project, aiming to increase the electricity output from Lahendong geothermal plant to 158 GWh (Giga-watts hour) annually into PLN's Minhasa system of North Sulawesi; see on: World Bank 2009, 'ID-PCF-Indonesia Lahendong Geothermal Project', 25 August, viewed 16 March 2011, at <http://web.worldbank.org/external/projects/main?pagePK=64283627&piPK=64290415&theSitePK=40941&menuPK=228424&Projectid=P096677>.

[26] JICA's contribution of ¥5,866 million (approx. USD 70 million), beginning in March 2004, involved building a new plant with a 20 MW capacity that is due for completion in 2012; see on: JICA 2004, 'Major projects: Lahendong Geothermal Power Plant Project', JICA, viewed 16 March 2011, at <http://www.jica.go.jp/indonesia/english/activities/activity13.html>.

Grid capacity

One of the more fundamental obstacles to reaching the government target is the fact that most geothermal resources are located in remote areas, which means additional financing is required to connect electricity production to the main grid (Tanoto & Wijaya 2011). Nationally, only 65 percent of the country's territory is connected to PLN's grid, most of it in the more developed Western islands; only 45 percent of eastern Indonesia is connected to the grid (Jakarta Post, June 2012) The Global Competitiveness Report 2009–2010 ranked Indonesia far behind Malaysia and Thailand in the quality of infrastructure, such as roads, port and air transport infrastructure, and electricity supply (ADB, ILO & IDB 2010).

Indonesia is currently trying to expand its infrastructure (i.e. transmission systems) with support from the World Bank with a loan of USD 225 million (World Bank 2010a). Without overhauling the grid system, geothermal energy development is likely to remain sub-optimal.

Policy framework

Another source of uncertainty, which translates to risk, is the confusion when it comes to division of power between central and local governments. With decentralization, regional governments are important because they become the official owners of the steam resource, whereas the central government plays an equally pivotal role providing expertise and underwriting the power purchase agreements (De Wilde 2010). While fine in theory, decentralisation seems to have only raised transaction costs. As a Jakarta-based development economist describes it, 'the state bureaucracy has a genius for producing more obstacles or disincentives' (Lacey 2010). A 2010 survey of Asia's bureaucracies rated Indonesia the second worst (Agence France-Presse 2010).

It is this lack of clarity around the country's energy policy framework and institutional arrangements (including the bureaucracy, the legal system and tendering process) that discourage investment in the industry.

Box F: Policy uncertainty = risk (source: GENI 2011)

Indonesia has an installed electrical generating capacity estimated at 26.9 GW with 85 percent coming from thermal (oil, gas, and coal) sources, 13 percent from hydropower, and 2 percent from geothermal sources (PLN 2009). Prior to the Asian financial crisis, Indonesia had plans for a rapid expansion of power generation, based on opening up Indonesia's power market to IPPs. The crisis led to severe financial strains on PLN resulting in PLN accruing over USD 5 billion in debt. The Indonesian government has been unwilling to take over the commercial debts of PLN.

In 2002, Indonesia's government undertook measures to liberalize the nation's electricity market with the intent of making it a more interesting investment opportunity for foreign companies. The 2002 Law, however, was annulled by the Constitutional Court of Indonesia in December 2004 on the grounds that it was not in line with Article 33 of the Indonesian Constitution of 1945, which states that "sectors of production which are important for the county and affect the lives of the people shall be controlled by the state." This decision was a major blow to government plans to bring in greater private sector participation. Annulment of the law meant that the country had reverted to Electricity Law 15/1985. In 2009, the Indonesian Parliament passed the Electricity Law No. 30, and although not as ambitious as the 2002 law, it introduced changes that would allow entities other than PLN to participate in electricity supply and aims to redefine PLN's roles and mandates. The law's implementing rules and regulations, however, are yet to be issued. (ADB, ILO & IDB 2010)

Impacts on forests

Geothermal energy development can have either positive or negative impacts on forests and terrestrial ecosystems. If explored and exploited using the best available technologies and taking into account sustainability principles, geothermal can provide an incentive for the proper management of forest and support the livelihoods of forest-dependent communities. Geothermal energy development, in partnership with local communities, can also be used to create 'social fences' around high conservation value forests, to prevent unwanted encroachment; this can be achieved by investing part of energy revenues toward forest protection and community development. The impacts of geothermal development on forest areas are tackled in more detail in section 6.

Social and environmental conflicts

The costs of developing geothermal energy can scale up considerably (and unexpectedly) if concerns over social and environmental issues are not addressed. In the late 80s-early 90s, there was severe public opposition to geothermal energy development in Mindanao, Philippines (Mindanao Geothermal Project), which was based on the following concerns: lack of consultation, lack of benefits, dislocated settlements, encroachment on ancestral domain, privatization of the PNOC-EDC (Philippine National Oil Company-Energy Development Corporation) and sale of forest patrimony (de Jesus 2005). PNOC-EDC (the developer) responded with a multi-stakeholder monitoring programme, an environmental guarantee fund, immediate re-settlement, provision of economic packages, protection of prior and ancestral rights, and protection of forest patrimony (de Jesus 2005). Having learned from this experience, the PNOC-EDC applied these measures to its Mt. Labo and Northern Negros Geothermal Projects (Pascual 2005).

A similar situation is taking place in Bali where the local government and communities are opposing a geothermal project in Bedugul area, which they claim is being built in protection/conservation forest areas (*Eco-Business* 2011). A second reason for rejecting the geothermal plant is the perception that the project is not suited to Balinese culture and religion (i.e. the plant dishonors sacred mountains and forests) (Geothermal Energy Association 2011). However with Bali's increasing electricity demand, the island can no longer afford to rely solely on fossil fuels. There is an opportunity here for Indonesia to learn from the Philippines, which has successfully tapped its geothermal resources to become the world's second largest geothermal based electricity producer.

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5. The Indonesian energy policy environment

5.1. Indonesia's energy policy and targets

In 2006, President Susilo Bambang Yudhoyono issued a decree that defined a new policy direction for the energy sector: Presidential Decree No. 5 on National Energy Policy stipulated an energy mix for 2025 that lowers Indonesia's dependence on oil and significantly increases the role of new and renewable energy, including geothermal energy.

New and renewable energy, which comprises geothermal, hydro, solar and wind power, biofuels as well as nuclear energy and liquefied coal, was expected to make up 17 percent of the energy mix. While geothermal energy's share was a mere 5 percent of the 2025 energy mix, the actual installed capacity was expected to increase seven fold compared to 2005 figures, given the fact that installed capacity had remained stagnant throughout 2005-2010. In 2010, the MEMR expanded the government target– new and renewable energy would make up 25 percent of the energy mix in 2025 (the vision of 25/25), with an emphasis on energy conservation and in conjunction with Indonesia's greenhouse gas emissions mitigation target of 26 percent reduction from business as usual scenario by 2020.Currently, DEN has formulated academic transcript for a new National Energy Policy).

5.2. Institutional challenges

The involvement of different ministerial institutions and agencies in the Indonesian energy sector creates a significant challenge in terms of coordination. Overlaps of duties and responsibilities among government agencies are common, particularly in the emerging sub sector of renewable energy and, more specifically geothermal energy. Resolving conflicts that arise often necessitate intervention by the President. For instance, Law No. 27 of 2003 on Geothermal viewed geothermal energy development as a mining activity, and as a result, prior to 2011, geothermal development[27] was banned in protected forests and/or conservation areas, in accordance with Law No. 41 of 1999 on Forestry that disallowed mining activities. Several policies were then issued to rectify this, including Presidential Regulation No. 28 of 2011 which permits underground mining[28] (i.e. geothermal) in forest protection and conservation areas, which was followed by a Memorandum of Understanding (MoU) between the MEMR and the Ministry of Forestry (MoF) No. 7662 of 2011 accelerating the issuance of permits for geothermal energy development. See Annex D for a comprehensive list of regulations specific to geothermal energy.

The MEMR and the Directorate General

Indonesia's energy sector is regulated by the MEMR (Ministry of Energy and Mineral resource [Kementerian Energi dan Sumberdaya Mineral or ESDM]), and agencies or directorates answering to the ministry. The Directorate General for Mineral, Mining and Geothermal Resources was responsible for regulating geothermal energy until 2010 when Presidential Regulation No. 24 established the Directorate General (DG) for New Energy, Renewable and Energy Conservation. Under this new DG, the Directorate of Geothermal was created to formulate policies on geothermal energy development, among its other tasks. The creation of a new and separate DG clearly signifies the rising importance of renewable and sustainable energy. However certain policy aspects of renewable energy had been previously managed under the DG for Electricity and the DG for Mineral and Coal, hence some coordination on policy implementation is required between these two DGs.

[27] One example is the confusion over land use experienced in a number of geothermal working areas (WKPs) managed by Pertamina. These WKPs were granted prior to the issuance of Law No. 41 of 1999 on Forestry. Law No. 27 of 2003 on Geothermal, however, stipulates that WKPs recognized prior to Law No. 41 are legal.

[28] It was reported in October 2011 that there are at least eight geothermal power plants (PLTPs) processing permit applications for land development to the Ministry of Forestry (Berita Satu 2011). These are PLTP Lumut Balai Unit I, II & III (South Sumatra), PLTP Kamojang Unit V & VI (West Java), PLTP Karaha Bodas Unit 1 & 2 (West Java), PLTP Iyang Argopuro Unit I (East Java), PLTP Kotamobagu Unit I, II, III & IV (North Sulawesi), PLTP Sembalun (West Nusa Tenggara), PLTP Bedugul Unit I, II & III (Bali) and PLTP Sukoria (East Nusa Tenggara) (Berita Satu 2011). Based on Presidential No. 28 of 2011, to utilize protection and/or conservation forest areas for geothermal, developers are required to secure permits from the Ministry of Forestry.

The DEN

The National Energy Council (*Dewan Energi Nasional* [DEN]), established under the 2007 Energy Law (Law No. 30 of 2007), is another influential institution in the field of geothermal energy. The DEN is an independent multi-stakeholder body tasked by the President with drawing up a master plan for the energy sector, designing policy responses to energy crisis and emergency situations as well as overseeing the implementation of said policies. The Council is chaired by the President, with the Energy and Mineral Resources Minister as the executive head of the council, and members from relevant line ministries in charge or affected by aspects of energy production, distribution, retail and use, as well as eight additional non-government stakeholders comprising the council. The master plan and relevant policies (particularly the National Energy Policy[30]) formulated by this council will address the availability of energy, energy development, the utilization of domestic energy resources, and energy supply reserves (including the utilization of geothermal resources) (*Reegle* 2010). Previously the responsibility of drawing a 10-year National Energy Master Plan (Rencana Umum Energi Nasional [RUEN]) rested solely in the hands of the MEMR.

As reported by various news sources (Nugroho 2011), the master plan appears to have been recently submitted for review, however it is unclear whether it has been finalized or integrated into wider planning documents, such as the recently published document 'Masterplan for Acceleration and Expansion of Indonesia's Economic Development', published by the Coordinating Ministry for the Economy, or in the long term economic development planning (Rencana Pembangunan Jangka Panjang [RPJP]) as prepared by the State Ministry for National Development Planning (BAPPENAS).

[30] The National Energy Policy of 2010-2050 has been drafted although yet to be enacted (DEN 2011). Prior to enactment, the existing National Energy Policy by Presidential Regulation No. 5 of 2006 applies (*Reegle* 2010). Based on the Draft of National Energy Policy of 2010-2050, the DEN (2011) has put significant emphasis on promoting new and renewable energy, particularly geothermal. In this draft, the DEN (2011) proposed the increase in new and renewable energy in the national energy mix from 5.7 percent in 2010 to 25.9 percent by 2025, 30.9 percent by 2030 and 39.5 percent by 2050. The DEN (2011) has also elaborated five key policy interventions on geothermal.

The UKP4

Another relevant non ministerial agency, recently established but rising in importance, is the Presidential Unit for Development Monitoring and Oversight (UKP4) that has been tasked with resolving bottlenecks in geothermal energy development (*The Jakarta Post 2010*; Mangkusubroto et al. 2012). The unit is dedicated to resolving fractious issues such as permits for exploration within forest conservation areas and project financing. Together with the office of the Vice President, UKP4 also helped conceive a ministerial decree on government guarantees for early phase development (*Bisnis Indonesia* 2011).

Ministry of Finance and Ministry of Forestry

There are two other line ministries that play a pivotal role in energy policy making, particularly as it relates to geothermal energy development. First, the Finance Ministry drives financial incentives crucial to attracting investors into the sector. For over a decade, the geothermal subsector suffered from lack of investment as the private sector was unwilling to take on the high risk of early phase development. Prior to the Asian crisis in 1997, government guarantees for electricity generation projects were the norm. However, the aftermath of the crisis saw these guarantees revoked, causing a slump in private investment in electricity generation (PwC 2011). The Finance Ministry's recent decision to extend guarantees to projects in its early phase development is instrumental in addressing this concern (*Bisnis Indonesia* 2011). Furthermore, the ministry, through its sovereign wealth investment agency, plays an important role in creating publicly funded initiatives designed to mobilize private capital, such as the Clean Technology Fund (World Bank 2010b).

The Ministry of Forestry also plays a crucial role in geothermal energy development as most identified reservoirs lie underneath protected forest areas. It is estimated that up to 42 percent of the potential geothermal resources or more than 12 GW are located in protected forest areas (MEMR 2011). Following Presidential Regulation No. 28 year 2011 permitting underground mining in protected forest areas, a joint ministerial agreement between the Energy Ministry and the Forest Ministry was issued that allows the pre-development of 28 geothermal working sites located in protected forest areas[31] , due to be auctioned in 2012. However, for developers to utilize Presidential Regulation No. 28 of 2011 and secure 'izin pinjam pakai' (permit to use the forest land) from the Ministry of Forestry, they require a recommendation letter from a district government, and this often proves challenging for a host of reasons: district government priorities may be different from central government's, district governments lack the capacity to process applications, or other issues linked to corruption, transparency, and the burden of additional transaction costs.

As such, the MEMR and the Indonesian Geothermal Association are proposing to amend Law No. 27 of 2003 so that geothermal development in forest areas is no longer considered a 'mining activity' (Wahyuni & Rahman 2011); this proposed amendment may have to wait however as it was not incorporated in the 2012 National Legislation Program (Program Legislasi Nasional [Prolegnas]).

[31] Nota Kesepahaman antara Kementerian Energi dan Sumber Daya Mineral dan Kementerian Kehutanan tentang Koordinasi dan Percepatan Perizinan Pengusahaan Panas Bumi Pada Kawasan Hutan Produksi dan Kawasan Hutan Lindung serta Pengembangan Panas bumi pada Kawasan Konservasi". This Memorandum of Understanding between the MEMR and the Ministry of Forestry (MoF) No. 7662 of 2011 regulates the coordination and acceleration of the permits to develop geothermal energy in forest production and protection areas as well as in forest conservation areas. This agreement is effective for three years following its signing.

[31] Nota Kesepahaman antara Kemen For example, some regions are landlocked and have no access to a port. The adjacent region that controls the nearest port will usually ask for a toll fee, which may be so large as to render any commercial initiative not viable.

5.3. Public monopoly in the electricity sector

For decades, PLN has reigned over the Indonesian electricity market. Until 1985 PLN was the sole producer of electricity, and despite the presence of a liberalized power generation market, PLN and its subsidiaries continue to dominate the market. PLN remains the single buyer of electricity generated by independent power producers (IPP), as it owns and operates the transmission networks that run through the country. However, PLN's inefficient operations and failure to meet demand in a reliable manner has forced the government to introduce reforms into the electricity market, which has stripped PLN, albeit gradually, of its monopoly status.

The 2009 Electricity Law, passed five years after the Constitutional Court annulled a similar law passed in 2002, sought to liberalise the electricity market, therefore ending PLN's dominant position in both power generation, and in transmission and retail of electricity. The law allows local governments to provide electricity to their region directly from private companies, which meant bypassing PLN's networks. While PLN retains the right of first refusal to develop new power generation projects, local governments have the authority to approve new projects. At the same time private producers may propose tariffs that reflect the market price of power generation (BMI 2010).

Both PLN and the local governments are required to prepare a ten-year electrification development plan to be approved by the Energy Ministry. PLN has also been mandated to develop The Electrification Development Program 2010-2019, based on the master plan (RUKN) developed by the Energy Ministry, whereas local governments are required to prepare a Regional General Plan of Electricity (RUKD) based on the RUKN (PwC 2011).

5.4. The impacts of decentralization

Indonesia has undergone far-reaching political and fiscal decentralization since 1999, but it was only with the passing of the 2009 Electricity Law that energy planning has been devolved to the district government. The law provides a greater role for district and municipal governments to participate in the provision of electricity services, such as energy planning and setting a regional/local tariff within the bracket established by the central government (and approved by the parliament). However, details remain unclear as implementing regulations have yet to be issued.

The situation is similar when it comes to geothermal energy development. The 2003 Geothermal Law (No. 27 of 2003) grants regional (i.e. provincial and district) governments the authority to develop geothermal energy; they handle licensing, competitive tendering and deal directly with investors (*Reegle* 2010). Under this law, provincial and district governments have become the owners of geothermal resources in their constituency although they still have a joint responsibility with the MEMR to develop the field and monitor the exploitation (President of the Republic of Indonesia 2010).

Encouraging provincial and district governments to develop geothermal energy is an enormous challenge (particularly when issues can only be resolved through negotiation and cooperation across regions), as most have little expertise and a limited understanding of energy scenarios and energy development. Provincial and district governments require expert guidance and resources from the central government to develop the capacity to tender and monitor the exploration and exploitation of geothermal working areas (Girianna 2009). Developing WKPs is likely to be one of the bigger challenges in realizing geothermal energy development, as the tendering process requires interest, ownership and strong capacity at the local level.

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6. Balancing geothermal energy and forest conservation

6.1 Managing geothermal development in Indonesia's remaining forest areas

Geothermal energy development in Indonesia is unique in the sense that much of the development is likely to take place in the country's remaining important forest areas. As mentioned earlier, up to 42 percent of potential geothermal resources or more than 12 GW are located in protected forest areas (MEMR 2011) and are subject to the recently enacted law on pristine forests, which include stricter conditions under which licenses are issued (Girianna 2009; Satriastanti 2011; *The Jakarta Post 2011*). The Memorandum of Understanding No. 7662 between the MEMR and the Ministry of Forestry (MoF) signed in 2011 fast-tracks the permits for geothermal energy development in production forest and protection forest areas, while also preparing conservation forest areas[32] for geothermal utilization; the MOU follows Government Regulation No.2 of 2008 which approved geothermal energy development in production and protection forest areas in exchange for tariff or government income.

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[32] Production forest means a forest area having the main function of producing forest products; Protection forest means a forest area having the main function of protecting life-supporting systems for hydrology, preventing floods, controlling erosion, preventing sea water intrusion and maintaining soil fertility; Conservation forest means a forest area with specific characteristics, having the main function of preserving plant and animal diversity and its ecosystem.

Box G: Geothermal energy's land requirements

Geothermal power facilities do not need large tracts of land– an entire geothermal field spans 0.4-3.2 hectares per MW versus 2.02-4.04 hectares per MW for nuclear plants and 7.67 hectares per MW for coal plants. Figure 12 illustrates the projected total land area required to develop geothermal energy for various energy scenarios. Both the government and WWF's Ring of Fire targets require 26,570 hectares to build 9,500 MW by 2025. This figure is small compared to other development activities in Indonesia (i.e. forestry, energy and agriculture).

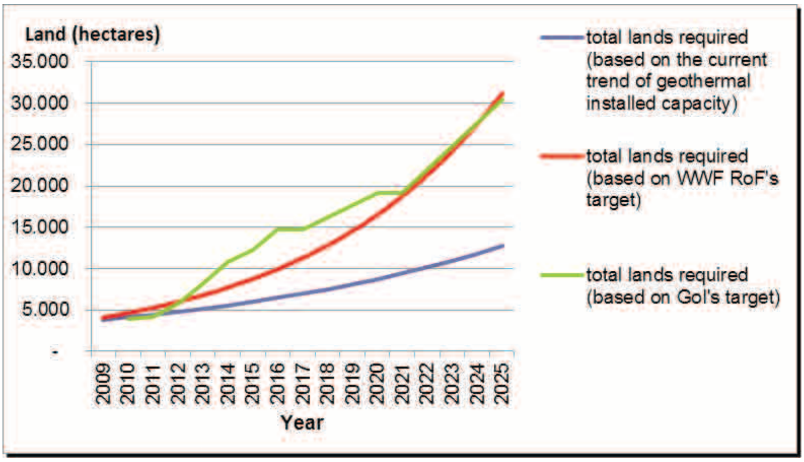

Figure 12: Projection of total lands required for geothermal energy development (source: Authors' calculation)

With such explicit policy support for accelerating geothermal energy development, it is imperative that measures are taken so that lands acquired for geothermal energy use are not high conservation value forests or sensitive ecosystems, and that the impacts and risks on forests are mitigated. The case study of Gunung Salak (see Box C) is a good example of balancing geothermal development with forest conservation.[34] Some likely impacts of geothermal development include the loss of forests and terrestrial ecosystems, forest fragmentation[35] resulting in habitat modification or destruction of surrounding flora and fauna, release of toxins (such as hydrogen sulphide) during plant operation, stress on sensitive forest ecosystems from increased human incursions, and potential disruption of the natural water cycles of forest ecosystems.

[34] Another example (outside Indonesia) is Hell's Gate National Park in Kenya that was established around an existing 45-MWe geothermal power station, Olkaria I. Land use in the park include livestock grazing, growing of foodstuffs and flowers, and wildlife conservation. After extensive environmental impact analysis, a second geothermal plant, Olkaria II, was approved for installation in the park in 1994, and an additional power station is currently under consideration.

[35] Forest fragmentation is caused initially by the development of roads and other infrastructures used to facilitate the development of geothermal power plants. Such infrastructures attract hunters (and poachers), illegal loggers, colonists (illegal encroachers/ settlers) or invasive and introduced species. The development of these infrastructures can also break up the habitats of migratory and nomadic animals, leading to declines in feeding, mating and survival rates. Such impacts have been reported as part of the consequences of geothermal energy development in Turkey, Hawaii and the Philippines.

WWF's Ring of Fire project is currently developing, in collaboration with key Indonesian stakeholders, sustainability standards designed to prevent environmental and socio-cultural impacts and ensure the sustainability of geothermal energy development.

WWF has often promoted the HCVF (High Conservation Value Forest) (http://wwf.panda.org/what_we_do/how_we_work/conservation/forests/tools/hcvf_toolkit/) concept as a useful tool in cases where sectoral development may potentially disrupt or impact forest and terrestrial ecosystems. HCVF identification and management has been used to promote sustainability and balanced development in forestry, bioenergy, plantation, agriculture, and finance.

Some practical steps to balance geothermal energy development and forest conservation include: providing replacement land double the size of the actual forest area used by geothermal operations; implementing extensive reforestation at the unused project sites; minimising forest usage and control land clearing; maximizing the use of existing cleared areas to extend surface facilities; maintaining close supervision on the drivers of earthmoving equipment, in order to prevent unnecessary tree cutting during site clearance and construction; and avoiding forest fragmentation leading to loss of animal pollinators and predators and a decrease of species balance.

BOX H: Key measures to manage social issues related to forest use in geothermal development

1) Conduct 'Free, prior and informed consent' public consultation: 'Free prior and informed consent' (FPIC) is the principle that a community has the right to give or withhold its consent to proposed projects that may affect the lands they customarily own, occupy or otherwise use. FPIC is now a key principle in international law and jurisprudence related to indigenous peoples (http://www.forestpeoples.org/guiding-principles/free-prior-and-informed-consent-fpic).

2) Implement awareness and acceptance programmes: Prior to any discussion about a project, the company/developer must introduce itself to the stakeholders. As a standard procedure, the company should conduct information drives targeting its various stakeholders, consisting of the local government units (LGUs), government agencies, host communities, non-governmental organizations (NGOs), peoples' organizations (POs) and private business. (See De Jesus 2005).

3) Create a multi-stakeholder monitoring team: Ensure that mechanisms are in place so that project activities can be monitored by a Multi-Sectoral Monitoring Team (MSMT) composed of representatives from the local government units, host community, NGOs, the Department of Environment and Natural Resources (DENR) and other concerned sectors in the area (See De Jesus 2005).

4) Set up an environmental guarantee fund: This is a financial arrangement negotiated between the proponent, the government and the affected community. The amount is intended for rehabilitation and payment of damages due to the accidents from the operation of the project (De Jesus 2005).

5) Provide economic packages: Social acceptability is often equated with the stakeholders' access to meaningful benefits or benefits that have direct positive impacts. These need to be shared equally with communities in recognition of their contribution to national security and national development for hosting the project. (See De Jesus 2005).

6) Resettle dislocated communities, if necessary

7) Protect prior and ancestral rights: Ancestral domain shall be fully recognized and protected by the project.

8) Protect forest patrimony: Ensure that the project will not disrupt forest patrimony.

6.2 Case study: Sumatra from thermal to green

Sumatra is Indonesia's second most populated island, with nearly 50 million inhabitants. As a hub for timber, agricultural and industrial production, the island boasts an economic growth of 2.17 percent (Liun 2010). This figure however is far below Sumatra's growth potential, hobbled as it is by a shortfall in energy supply. In the aftermath of the 1997 Asian crisis, while electricity demand dropped across Indonesia, Sumatra's demand grew at a steady 10.3 percent (Liun 2010). In 2000, increasing demand finally surpassed electricity supply and, as a result, electricity shortages have plagued the region since. According to PLN (2010), Sumatra's electricity demand growth is projected to reach 11 percent, which requires an installed capacity of 6,970 MW by 2015 and 23,300 MW by 2030 (see Figure 13).

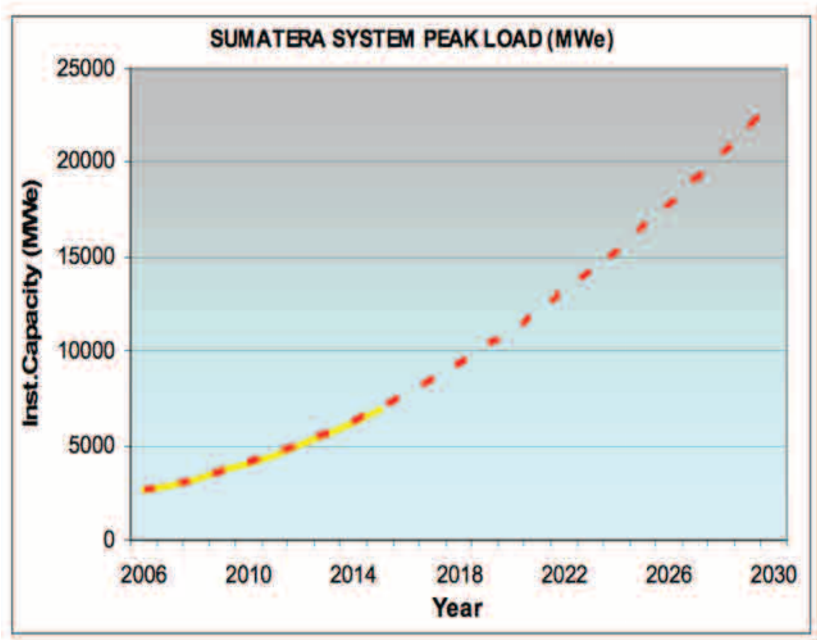

Figure 13: Sumatra Peak Load Projections until 2030 (Liun 2010)

Fossil fuel dependence

Sumatra is supplied mostly by small thermal power plants spread over the region, some as off-grid generators that feed electricity directly to industrial facilities. Coal makes up 64 percent of primary energy supply for electricity generation (Liun 2010), particularly in the southern areas where the resource is abundant and big industries such as cement and pulp and paper have their own small thermal plants. Oil, on the other hand, has been widely used in power generation in the northern part of the island; 73 percent of all electricity in the northern provinces is fuelled by oil, in contrast to 8 percent in the southern provinces (Liun 2007; Liun 2010). Natural gas, along with mini hydro power make up a small proportion of the island's fuel mix. In 2010, geothermal energy only made up 2 MW of installed capacity.

BOX I: Sumatra's evolving grid system

Historically, five separate grids served the island. Recently however three grids in the southern, western and central part of Sumatra have been interconnected, forming the South Sumatra grid system. Similarly, the two grids in the north have been interconnected, forming the North Sumatra grid system (ADB 2002). Plans to connect the North and South Sumatra grid system have been on the table, but no specific timeframe has yet been announced. Indonesia also reportedly plans to invest USD 2 billion in a power grid linking Sumatra to Java that will be completed in 2016. The 700km power grid will include 40km of underwater HDVC power cables that will connect the Java-Bali grid to the Southern Sumatra grid, to access energy from mine-mouth plants being planned in South Sumatra (ADB 2002; Silviati, 2005).

Figure 14: Sumatra grid system

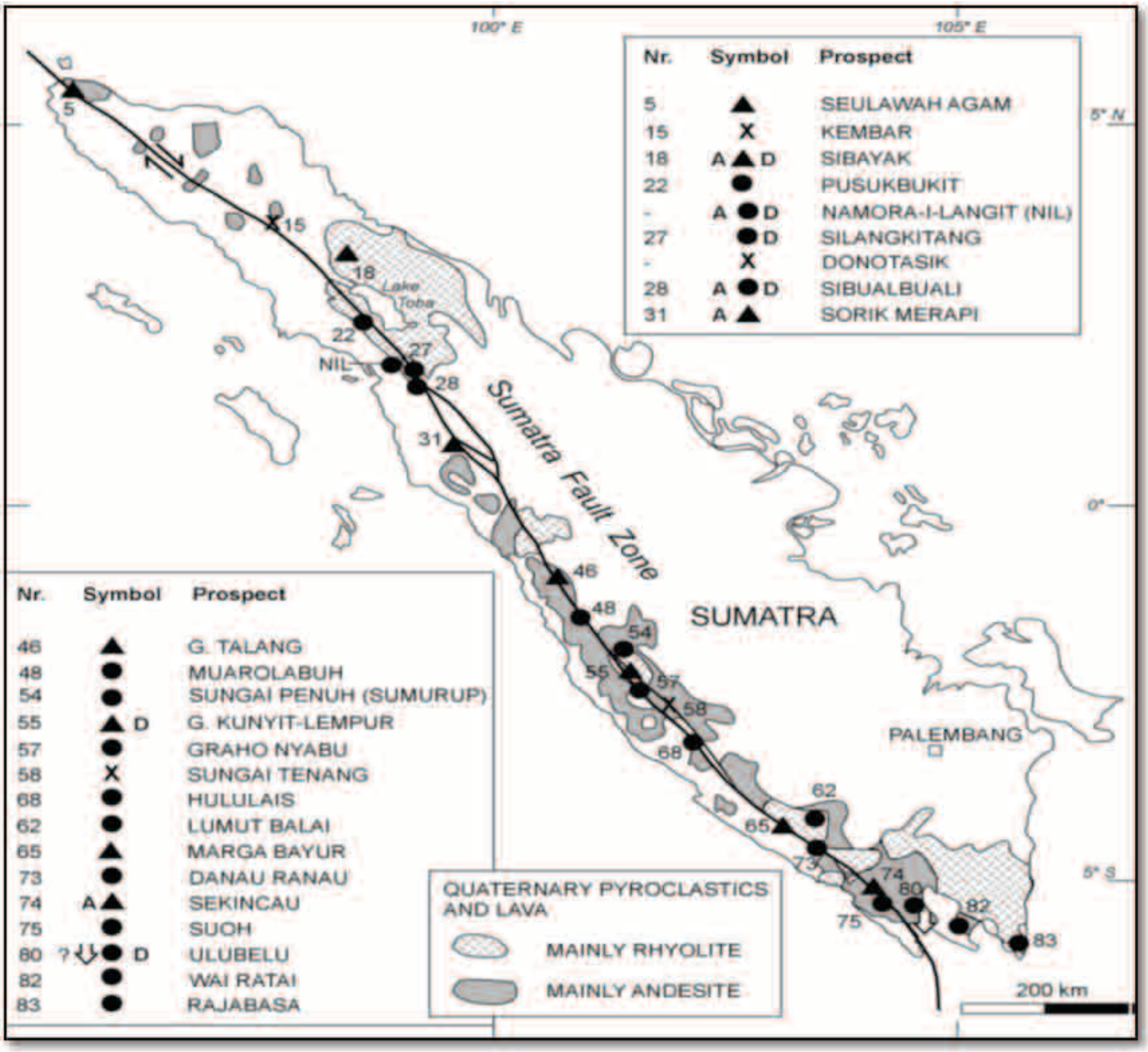

Figure 15: Location of high-temperature geothermal prospects on Sumatra explored between 1970 and 2000 (source: Hochstein & Sudarman 2008)

Managing geothermal exploitation in Sumatra's forests

As detailed in section 3, Sumatra has rich geothermal potential: 7,066 MWe of potential resources, 6,320 MWe of reserves and 12 MWe of installed capacity. Reconnaissance surveys undertaken between 1970 and 2000 have identified a number of geothermal prospects on the island (see Figure 15). In response, the government plans to develop, as part of the country's second-phase crash programme, 2,605 MW of geothermal power plants on Sumatra alone (around 53 percent of the total national capacity planned for Indonesia).

However, Sumatra's natural environment has been under much strain due to resources exploitation. A 2010 technical report found a steep decline in forest area from 25.3 million hectares (58 percent of land cover) in 1985 to 12.8 million hectares in 2008/2009 (29 percent), which equals an annual loss of 0.54 million hectares (approximately eight times that of Jakarta's territory) (Ministry of Home Affairs et al. 2010).

In an attempt to rescue the situation, the central government represented by four ministries (Environment, Home Affairs, Public Works and Forestry) agreed to collaborate with Sumatra's governors to protect the island's remaining ecosystems (Ministry of Home Affairs et al. 2010). In 2008, the Sumatra Ecosystem Roadmap was launched, and its first project was centered on the Bukit Barisan, a 1,700-kilometer mountain range that runs the entire length of Sumatra (Satriastanti 2010). But as it so happens, Bukit Barisan is also the site of proposed geothermal power plants in the government's second crash programme (see Figure 16).

While Sumatra's Roadmap provides ample policies, guidance (including spatial information) and action points for sustainable forestry, agriculture and tourism (Ministry of Home Affairs et al. 2010), it has yet to take geothermal energy into account. In light of plans to accelerate geothermal development on the island, it is critical for the Roadmap's facilitators (the four ministries, 10 governors and relevant NGOs) to collaborate with the MEMR, the PLN and the geothermal industry to build a sustainability criterion that balances geothermal development and forest conservation.

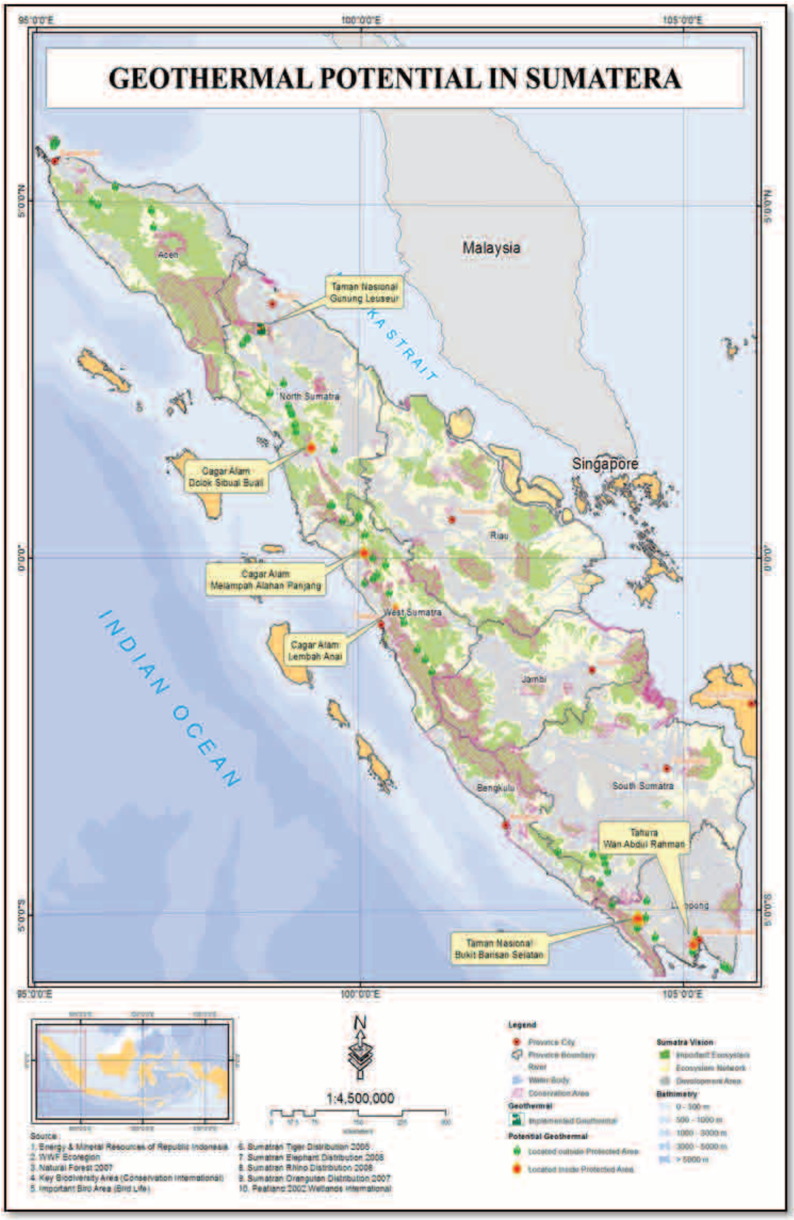

Figure 16: Geothermal potential in Sumatra overlaying with forest protection/conservation areas (source: The work undertaken by the GIS-Spatial Planning of WWF-Indonesia)

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7. Financing geothermal development

In the wake of the global recession, the past years witnessed a slump in investments in renewable energy. Recent developments suggest however a renewed interest in the sector–UNEP's Sustainable Energy Finance Initiative and Bloomberg's New Energy Finance (2010) documented a global surge in investments (USD 211 billion) in 2010, driven primarily by wind energy in China and household solar PV in Europe. Although in 2011 Pike Research projected a 134 percent increase in geothermal installed capacity by 2020, in response to high oil prices and the threat of climate change.

There has also been a noticeable increase in public investment in sustainable energy companies, amounting to USD 14.1 billion in 2009, as governments resorted to "green stimulus" to keep their economies afloat (UNEP & New Energy Finance 2010); such interest spell an opportunity for building innovative public-private partnerships to support geothermal energy development in Indonesia, particularly for early stage financing.

7.1. Reducing investment risks in Indonesia's geothermal sector

Indonesia's energy sector has only recently become a lucrative destination for foreign investment, as it was previously dominated by state owned companies. In 1985, limited private sector participation in the form of independent power producers was allowed in the electricity sector. However PLN remains a monolith, continuing its role as the single biggest buyer, distributor and price negotiator in the market (PwC 2011). The upstream and downstream business of transport fuels have also long been controlled by Pertamina, and only just liberalised to allow some form of competition, notably on the retail side. Section 5 discusses the issues related to public monopoly in the electricity sector.

As Chevron's president of Asia-Pacific exploration and production Jim Blackwell points out, Indonesia is unlikely to become a world leader in geothermal until there is 'a stable legal and regulatory regime, which allows for long-term development rights, open markets created by long-term contracts and long-term prices with certainty of payment' (*United Press International* 2010).

BOX J: The 'negative list' for investment

Under the 'negative list' policy, all projects below 10MW are reserved exclusively for Indonesian companies (Norton Rose 2010). The regulation also stipulates that plants with capacity between 1-10MW must be carried out by a partnership, although the requirements for this partnership are not clear (Norton Rose 2010). The 'negative list' for investment is likely to discourage foreign interest in Indonesia's energy sector.

The "negative list", as set out in Perpres Nos.77/2007, 11/2007, and 36/2010 prescribe a set of business activities which are closed for investment or which have limitations on foreign participation.

The negative list generally limits foreign ownership to 95% for investments in the production, transmission and distribution of electricity (including for O&M of electrical power/geothermal installations). In recent changes, Presidential Regulation No.36/2010 extended foreign ownership as follows:

a) small scale power plants (1-10MW) are now open to partnerships with small-medium businesses and cooperatives ("UMKK"); and

b) geothermal support services such as O&M services may have a maximum foreign ownership of 90% and for drilling services a maximum of 95%.

As a result, foreign investors are generally limited to a 95% equity interest in companies producing electricity (conventional or geothermal based) and to 90% of an entity performing operations and maintenance service for geothermal energy.

Figure 17: **The 'negative list' for investment**

Apart from the risks inherent in the natural monopoly that is the electricity sector, another immediate risk is associated with the costs of geothermal resource exploration. As mentioned earlier, drilling in just one location can easily reach EUR15-20 million (KfW 2011), with no guarantee that anything will be found. The risk could be mitigated by a revolving trust fund, for example, with repayments to the fund coming from the income provincial and district governments receive from the exploitation of geothermal concessions; however no serious effort has been made to this end.

Nonetheless, Indonesia has undertaken some measures to address the risks faced by the private sector in the preliminary phases of geothermal development.

- **Improved reliability of geothermal resource data** – The surveys and advanced explorations are run solely by the Energy ministry's geological agency. The scope and accuracy of the exploration data determine the level of risk that private entities take on once they have won an auction for a working area. However private developers and investors continue to question the quality of surface exploration data, as Indonesia lacks a well-defined standard to organize the characteristics of a geothermal field. Several countries have adopted the "Australian Code for Reporting of Exploration Results, Geothermal Resources and Geothermal Reserves The Geothermal Reporting Code".

- **Provided access to government guarantees** – In 2011, the Finance Ministry issued a decree, stipulating government guarantees for geothermal projects that are part of the second phase crash programme, and have reached the construction phase. The Finance Ministry later revised the decree to extend the guarantee during the exploration phase, as the risks associated with exploration are significantly higher than power plant construction and steam field operation. However, the revision, which was issued in August 2011, demanded that project developers secure financing within 48 months after the guarantee was issued or they risk losing it (*Bisnis Indonesia* 2011).

- **Established the Indonesian "Fit Fund" and the geothermal exploration mitigation facility** – The 'Fit Fund', developed by BAPPENAS and international partners (i.e. development banks) in 2010-2011 (see figure 18), is designed to support geothermal energy projects that have won tenders but cannot continue development, as they require a tariff above US 9.7 cents/kWH (Beukering 2012). The Fit Fund pays the difference between the price required by geothermal developers and the current electricity price.

In 2011, the government established a USD 128 million fund (Castlerock 2010), which local governments can access to finance exploration drilling. However, with this model, the risk now lies with the local governments, who will have to repay 100 percent of the loan.

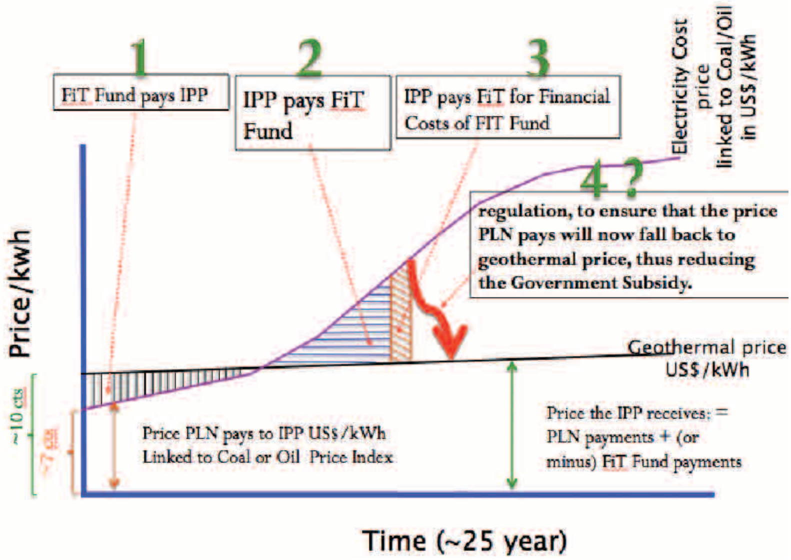

Figure 18: **Indonesia's Fit Fund** (Beukering, 2012)

7.2 The role of carbon financing

Carbon financing, notably through UNFCCC's Clean Development Mechanism, serves as a useful tool to boost the creditworthiness of a project and helps it to obtain the necessary financing, particularly during the early stage development. It monetizes the advanced sale of emission reductions and either boosts project return, raising the IRR (internal rate of return) to attract investment or enhances project equity value for equity or debt investment (NREL 2011). Figure 19 shows the average annual CERs (certified emission reductions) of different countries and Figure 20 presents the cash flow of CDM.

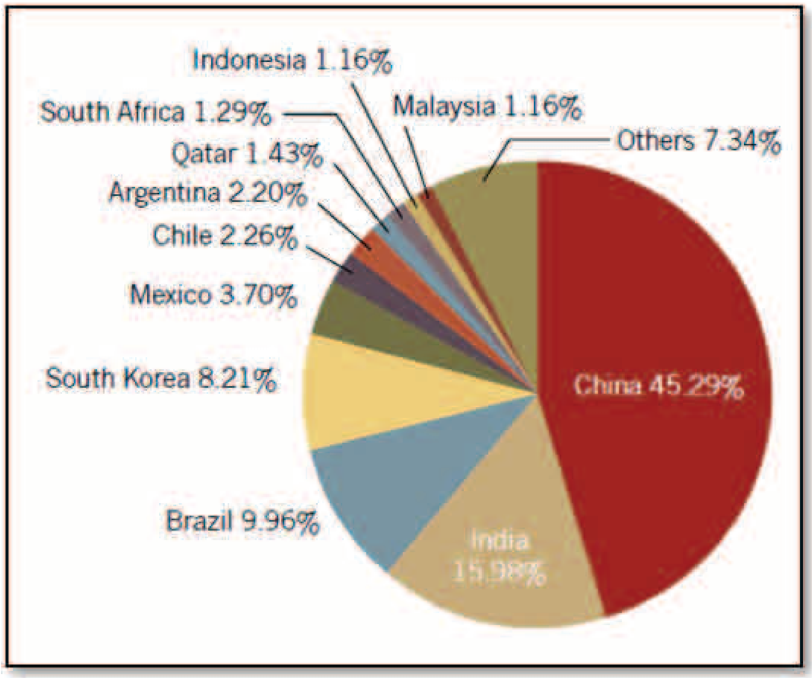

Figure 19: **Average annual CERs by host party** (source: UNFCCC 2007) (INA: Use updated data from link: http://cdm.unfccc.int/Statistics/Issuance/CERsIssuedByHostPartyPieChart.html)

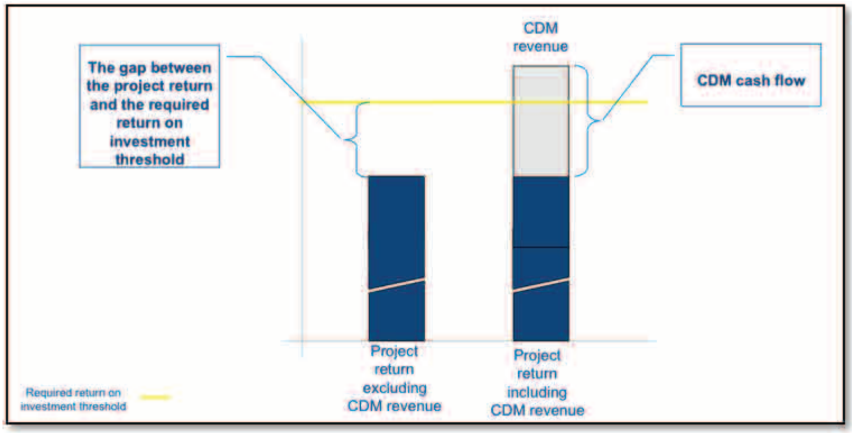

Figure 20: CDM cash flow within project financing (source: Martens 2005)

Recognizing that each ton of GHG emission reduction can be securitized and sold in the emerging GHG market, Indonesia has much to gain from developing geothermal carbon-financing opportunities. Indonesia's UNFCC National Communication and recent Conference of Parties (COP)-related 'position statements' have begun to actively promote geothermal energy as a means to reduce GHG emissions. With this potential to attract carbon-financing, geothermal energy development is included in ICCSR (Indonesia Climate Change Sectoral Road Map) and Indonesia GHG Emission Abatement Cost Curve published by DNPI (*Dewan Nasional Perubahan Iklim* [National Council on Climate Change]). However, geothermal energy has been omitted from the Presidential Regulation No. 61 of 2011 on National Action Plan to Reduce GHG emissions; and this omission has left many wondering how the government views geothermal energy's role in attracting carbon- financing.

In addition, although the future structure of the carbon markets is difficult to predict especially with the absence of a successor to the current global agreement, based on prices[36] of emission reductions in recent carbon finance transactions alone, revenues in the order of USD 0.005/kWh – USD 0.01/kWh can be generated through the sale of emission reductions. As a result, carbon finance potentially provides a useful source of funds that can be utilized to bridge the incremental costs associated with geothermal development in Indonesia and an important option to consider as part of a comprehensive pricing policy.

However, there is a need to reform CDM in view of its currently weak environmental integrity, as manifested by the volume of carbon credits from questionable projects (e.g. fugitive gases destruction) in the compliance market. A reformed CDM with enhanced environmental integrity increases the chances of substantive projects like geothermal energy getting access to carbon financing.

[36] http://unfccc.int/files/cooperation_and_support/financial_mechanism/application/pdf/potential_of_carbon_matkets.pdf

8. Challenges, Opportunities and Recommendations

In this concluding chapter, we summarise the key challenges that face geothermal energy exploration and development, such as the contentious issue of energy subsidies, which create political volatility in the sector and keep potential investors at bay. We also look at the opportunities that opened up in recent years for advancing the geothermal agenda: increasing energy demand, the government's more ambitious electrification target, and the challenge of climate change mitigation make geothermal energy a more attractive option. And finally, we enumerate the mix of policy and economic strategies necessary to take geothermal energy development in Indonesia to the next level.

Challenges

- **Energy subsidies** distort the electricity market price in Indonesia. Fossil fuels appear relatively cheaper, and are therefore preferable to geothermal energy.
- To accelerate geothermal energy development requires significant financial investment and less than superficial governance reforms. Investors perceive the **lack of clarity** around the country's policy framework and institutional arrangements as a high risk.
- An **overlap of duties and responsibilities** between government agencies creates confusion and throws down roadblocks in geothermal energy development. One such example is the tendering process, which creates conflict between local governments and the MEMR. (A one-stop shop, similar to what the Indonesian Investment Promotion Agency (BKMP) has undertaken for foreign investors, may be one solution.)
- Most provinces and districts have little expertise and very **limited understanding** of the implications of various energy scenarios.
- The prohibitive costs of developing geothermal energy (around USD2.4 million/MW) and the upfront **investment risks** are deterrents for investors.
- Building geothermal power plants in **remote areas** requires extra financing to connect electricity production to the main grid.
- Private developers and investors question the **quality of surface exploration data**. Indonesia lacks a well-defined standard to organize the characteristics of a geothermal field. Several countries have adopted the "Australian Code for Reporting of Exploration Results, Geothermal Resources and Geothermal Reserves The Geothermal Reporting Code". It would be ideal if Indonesia were to adopt its own code.
- Without considering the social and environmental aspects of development, the economic cost of geothermal energy development can increase significantly. **Negative public perception** can lead to rejection of the project by local government.
- **The overlap** between geothermal fields and protection/conservation forests has created confusion and delayed the process for acquiring the permit for land clearing from the Ministry of Forestry. Prior to 2011, Law No. 41 of 1999 banned geothermal energy development–categorized as a mining activity–in protected forest areas. Several policies were subsequently issued to rectify this, although these policies may prove inadequate.
- The **land requirement** for geothermal energy development is relatively low, but there is a need to avoid using high conservation value forests or sensitive ecosystems.
- The process of developing WKP with its **tendering system** is most likely to be one of the biggest challenges in realizing geothermal energy development.
- **Pricing** remains a key issue. Although tariff has been increased to US 9.7 cents/kWh, some developers have asked for a higher price to offset huge costs incurred in developing geothermal energy, especially in remote areas.
- The omission of geothermal energy from the Presidential Regulation No. 61 year 2011 on National Action Plan to Reduce GHG emissions leave many wondering whether the government priorities geothermal energy in its **climate change mitigation scheme**.

Opportunities

- In seeking to **reduce the financial burden** of energy and fossil fuel subsidies, Indonesia look to increase renewable energy's share in the country's energy mix.
- The increasing demand for electricity and the government's new target electrification ratio opens up an opportunity for indigenous and **sustainable energy resources** such as geothermal energy.
- **Climate change mitigation commitments** prioritise renewable energy sources, geothermal in particular, which can help address escalating concerns over GHG emissions. By increasing the use of geothermal energy in their model, Tanoto and Wijaya (2011) illustrate that as early as year 2014 GHG emissions from the scenario with increased geothermal capacity will begin to decline. At the end of the planning horizon, the business-as-usual scenario emits as much as 487 million tonnes of CO_2e, while the geothermal scenario will have reduced emissions by 43.3 million tones.
- Geothermal resources have been commercially extracted and used for more than a century. The nature of the technology makes geothermal suitable to **provide base-load electricity generation**.
- Sumatra has the largest geothermal resource potential and yet has the lowest installed capacity. Geothermal resources in this island are ideal for electricity production. Sumatra is an opportunity not merely to expand geothermal capacity but to build a sustainability criterion that **balances geothermal development and forest conservation**.
- Based on different development scenarios, geothermal energy can **generate** as many as 37,000-206,000 **jobs** by 2015 and 61,000-325,000 by 2020.

Recommendations

To realize and accelerate the development of geothermal energy, this report recommends the following policy, institutional, economic and financial measures:

- Substantive institutional reforms are key issues. Not merely creating a new institution to tackle coordination issue but the most important thing is to provide a clear mandate to which institution that leads the process of geothermal energy acceleration.
- Investments in capacity building at the regional government levels (i.e. provincial, district authorities) and for key proponents of geothermal energy development (e.g. developers) in managing geothermal resources are important, particularly for the energy planning and tendering process.
- Reduce if not completely eliminate subsidies for fossil fuels and provide sufficient capital to support sustainable geothermal energy development.
- To accelerate geothermal energy development, overall economic incentives system needs to be improved, which includes further reforming energy prices so that they reflect true market prices. Geothermal energy prices should be bankable to improve its access to fund and consider project risk, which will be different in each location.
- Reduce exploration and other early stage development risks by improving completeness and reliability of exploration data and implementing risk-mitigation measures.
- Stimulate commercial financial institutions to support renewable energy including geothermal and also formulate financial instruments that can reduce resource risk and accelerate Indonesia's geothermal energy development.

- Expanding the grid is urgent and critical. Without overhauling the grid system, geothermal energy development is likely to be sub-optimal. In addition to the improvement of the existing grid, the need of local communities to have an access to electricity requires to be seriously addressed.
- With explicit policy support for accelerating geothermal energy development in forest areas, it is imperative that measures are taken so that lands acquired for geothermal energy use are not high conservation value forests or sensitive ecosystems, and that the impacts and risks on forests are mitigated. WWF's Ring of Fire project is currently building, in collaboration with key Indonesian stakeholders, sustainability standards designed to manage environmental and socio-cultural impacts and ensure the sustainability of geothermal energy development.
- The proponents of geothermal energy development (e.g. investors, developers and the government) should anticipate and mitigate the social and environmental impacts of geothermal projects, as these can significantly increase the economic costs of development, and may even lead to costly delays.
- In particular, the development of different strategies is needed to lower the transaction costs of Indonesia's decentralised governance arrangements around energy investment and regulation. To reduce transaction costs should not be confused as an argument for deregulation, but should rather be seen as a call for the removal of uncertainties around regulatory decisions already taken and their replacement by efficient executive motors of implementation.

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10.

ANNEX A:

Approach and methodology

This report is supported by extensive literature as well as data – public and confidential – reviews and analyses (both qualitative and quantitative). Sources of the data vary ranging from peer reviewed journal articles, reports published by research institutions, governments and non-governmental organizations to newspaper articles. Since geothermal resources are spread out across Indonesia, the analysis in this report covers key regions Sumatra, Java, Bali and Eastern islands.

The report also extracts the results obtained from semi-structured interviews and focus group discussions with key stakeholders on the issue of energy governance conducted with the help from the first named author. These stakeholders included officials from state agencies, non-state actors, international organizations, and Indonesian specialists located both in Indonesia and abroad.

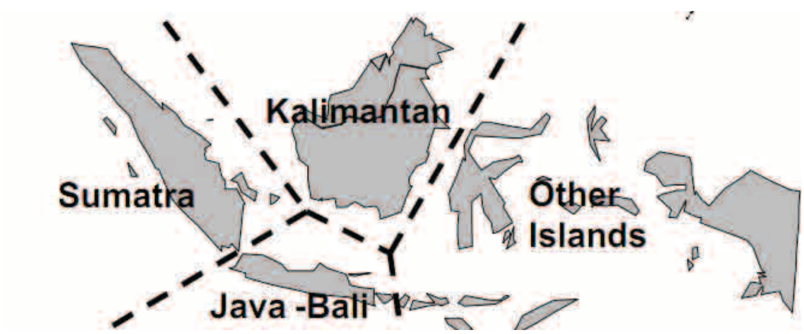

Figure 20: Breakdown of Indonesia into regions (source: BPPT, BATAN & ESDM 2002)

ANNEX B:

A Brief Review of Geothermal Energy Technologies

To decide whether geothermal energy is technically feasible for a country like Indonesia, understanding available technologies is a priority. There are three main conversion cycles currently used in geothermal power generation plants. The cycle used in a power plant is determined primarily by the nature of the geothermal resource, manifested in the reservoir temperature, well-head pressure and the quality of fluid exiting the well.

Geothermal resources have been commercially extracted and used for more than a century. The nature of the technology allows a steady production of heat, and thus is suitable to serve as a source for base load electricity generation. It is currently used as base load electricity generation in 24 countries, including Indonesia, with an estimated 67.2 TWh/year of supply provided in 2008, serving more than 10 percent of the electricity demand in 6 countries. In addition, geothermal has been used directly as a source of thermal energy for both heating and cooling in 78 countries, generating 121.7 TWh/year of thermal energy in 2008 (Goldstein et al. 2011).

Geothermal does not involve carbon intensive combustion process, which means direct emissions from its lifecycle mainly derive from the construction of the wells and power plants as well as underground fluids in the reservoir that may leach into the surrounding area. Studies show that direct emissions have been high in some instances with full range spanning from zero to 740g CO_2e/kWhe depending on technology design and characteristics of the reservoir. Lifecycle assessment shows emissions are less than 50g CO_2e/kWhe for flash steam geothermal power plants, less than 80g CO_2e/kWhe for projected EGS (enhanced geothermal systems) power plants (Goldstein et al. 2011).

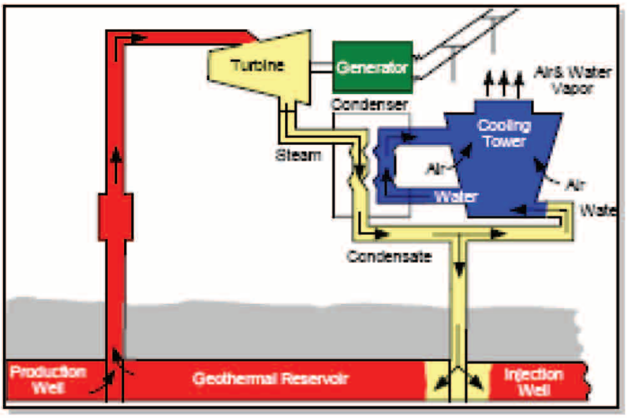

Figure 21: Schematic of a direct steam cycle (source: Idaho National Laboratory 2011)

Direct steam power cycle

The so-called direct steam geothermal plant is used for reservoirs that are vapor-dominated. The plant is also developed based on the natural geothermal fluids condition (Anderson & Lund 1979). The steam, after passing through separators (which remove sediments from the flow) is fed to the turbine. These were the earliest types of plants developed in Italy and in the U.S. Recent direct steam plants in the U.S., at the Geysers in California have been installed in capacities of 55 and 110 MW (Di Pippo 1999). Vapor-dominated reservoirs are the rarest of all geothermal resources and exist in only a few places in the world, including Indonesia. Globally, close to 28 percent of all electricity produced in geothermal power plants are obtained through the use of the direct steam power cycle (Di Pippo 2005). In addition, dry steam power plants have very low potential impact on the environment. The fluid from the well is comprised solely of steam, negating the need for disposal of mineral-laden brine. Non-condensable gases in the steam are usually removed by means of vacuum pumps or steam jet ejectors. A schematic diagram of such a cycle is presented in Figure 2.

Flash cycle

Flash steam plants are employed in cases where the geothermal resource produces high-temperature hot water or a combination of steam and hot water. Plants using this power generation cycle comprise 29 percent of all geothermal plants, and produce 40 percent of total global geothermal power (Di Pippo 2005). Plant units are usually rated at 30 MW, which are supported by 5-6 wells, and 2-3 wells for re-injection of the spent brine. The fluid from the well is delivered to a flash tank where a portion of the water flashes to steam and is directed to the turbine. The remaining water (referred to as brine) is directed to re-injection wells. Depending on the temperature of the resource, it may be possible to use two stages of flash tanks. In this case, the brine separated at the first stage tank is directed to a second stage flash tank where more (but lower pressure) steam is separated. Remaining brine from the second stage tank is then directed to disposal. The so-called double flash plant delivers steam at two different pressures to the turbine. A simplified representation of these two cycles is shown in Figures 3 (A and B).

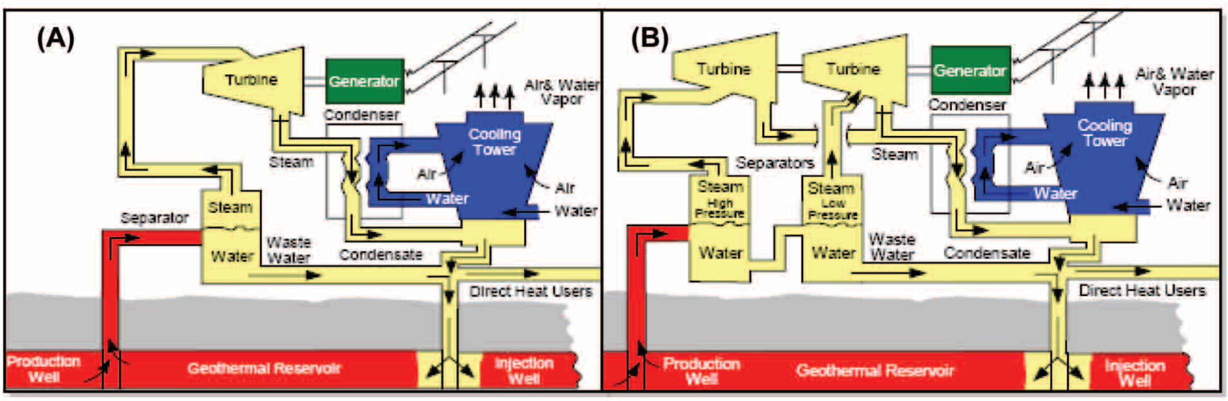

Figure 22: (A) Schematic representation of a single-flash cycle (source: Idaho National Laboratory 2011)**; (B) Schematic representation of a double-flash cycle** (source: Idaho National Laboratory 2011)

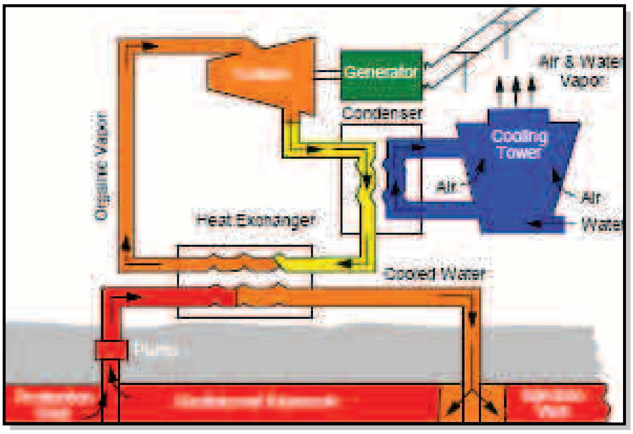

Figure 23: Schematic of a binary cycle (source: Idaho National Laboratory 2011)

Binary cycle

The third type of geothermal conversion technology is called the binary plant. In this type of plant, a secondary fluid in a closed cycle is used to operate the turbine rather than geothermal steam. Figure 4 presents a simplified diagram of a binary geothermal plant.

Geothermal fluid is passed through a heat exchanger where the heat in the geothermal fluid is transferred to the working fluid causing it to boil. The working fluid vapor is passed onto the turbine where its energy content is converted to mechanical energy and delivered, through the shaft, to the generator. The vapor exits the turbine to the condenser where it is converted back to a liquid. In most plants, cooling water is circulated between the condenser and a cooling tower to reject this heat to the atmosphere. The binary cycle is the type of plant which would be used for low temperature (i.e. T<170oC) geothermal applications (Di Pippo 2005).

No definite guideline exists as to what conversion technology should be used for the production of electricity from geothermal reservoirs. One approach is to determine the cycle type according to the reservoirs temperature. The simple reason for this approach is that temperature is the first and simplest parameter that can be measured in the exploration process of a reservoir.

Box K: The case for flash cycle technology in Indonesia

According to a 1997 detailed survey, it is reported that of the 217 prospects of geothermal energy, 70 are categorized at high temperature reservoirs (T>220oC), with a total potential of about 20 gigawatts-electrical (GWe) (Prijanto & Sudarman 1997). It is estimated that from this total potential, 49 percent is in Sumatra, 29 in Java-Bali, 8 in Sulawesi, and 14 in other islands (Prijanto & Sudarman 1997). By 2005, of the 15 power plants operating in Indonesia, three utilized the direct steam cycle (Di Pippo 2005). These three units are all in the Kamojang field. The single flash cycle is seen to be the most widely used electricity generation method for the conditions prevalent in the Dieng, Darajat, Gunung Salak, Lahendong and Sibayak (Di Pippo 2005).

Close to 49 percent of the potential for geothermal utilization lies in Sumatra (Prijanto & Sudarman 1997). Given the fact that flash cycle is a mature technology and has been used widely in various Indonesian power plants throughout the years, it would seem to be among the most favorable technologies if more geothermal power plants are to be built on this region (Di Pippo 2005). IEA technology roadmap for geothermal energy states that it is 'important to establish medium-term targets for mature technologies and long-term targets for advanced technologies, to help increase investor confidence and accelerates expansion of geothermal heat and power' (IEA 2010). Figure 5 shows the potential envisaged by high-temperature hydrothermal flash plants. Indonesia is seen to be well suited to contribute to this increase in production capacity.

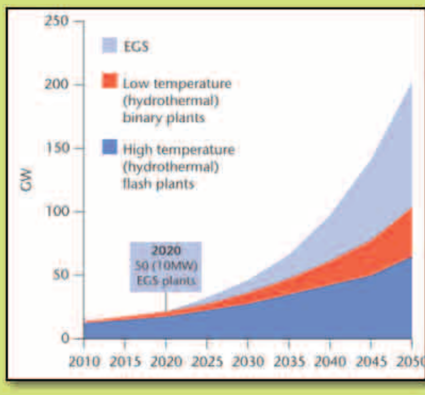

Figure 24: Growth of geothermal capacities by technology in GW (source: IEA 2011)

ANNEX C:

List of power plants under development as part of the Indonesian's government second phase 'crash programme' of 10,000 MW

(status and description updated from various sources as of March 2012, see Alfian 2010a; Alfian 2010b; Ardi 2011; Arifenie 2011; Asmarini & Rahman 2011; Berita Satu 2011; Business Standard 2010; Dabu 2012; Danpac Online Trading 2012; Darma et al. 2010; Dharmawan 2012; Elandis 2011; *Energy and Mineral Resources Ministerial Decree No. 1 of 2012; ESDM 2009a; ESDM 2011; Fadillah 2012; Ferial 2012; Fikri 2011; Geothermal ITB 2009b; Harian Orbit 2011; Investor Daily 2011; IRESS 2011; JDIH Aceh 2011; Kompas 2011a; Kompas 2011b; Malau 2011; Medan Satu 2011; Meryani 2010; NTB Terkini 2011; Obor 2011; Pertambangan-Geologi 2011; PGE 2011; Pikiran Rakyat 2011; Pikiran Rakyat 2012; Pos Kupang 2012; Pradipta 2012a; Pradipta 2012b; PwC 2011; Rachmawati & Hitipeuw 2011; Reportase 2011; Republika 2011; Riyandi 2011; Saleh 2011; Sari 2011; Sloetan 2011; Sukhyar 2011; Supreme Energy 2011; Suri 2009; The Energy Asia 2011; The Indonesia Today 2011; Timor Express 2012; Wahyuni 2012; Wartapedia 2011; Widyasari 2011; Wijaya 2012; Wika Jabar Power 2011)

No	Power plant	Province	Capacity (MW)	Total capacity (MW)	Status	Notes
PLN (Perusahan Listrik Negara [the State-owned Electricity Company]), but some have recently been transferred to private entities						
1	PLTP Tangkuban Perahu I	West Java	2 x 55	110	Reaffirmed as part of the government crash programme* with the accelerated development of the 10km of 150 kV transmission; PPA (power purchase agreement) in negotiation;	Developer: Indonesia Power; Price at US 5.8 cents/ kWh; Projection: the plant likely to be completed by 2015
2	PLTP Kamojang V & VI	West Java	1 x 30, 1 x 60	90	Reaffirmed as part of the government crash programme*; Tender awarded; PPA signed for unit 5 in March 2011; Exploration completed; Awaiting for drilling for production; In the process of getting the permit for land clearing from the Ministry of Forestry	Status unknown for unit 6; Developer: PT Pertamina Geothermal Energy (PGE); Price at US 8.25 cents/ kWh; The plant likely to be completed by 2014
3	PLTP Ijen	East Java	2 x 55	110	Reaffirmed as part of the government crash programme* with the accelerated development of the 60km of 150 kV transmission; Tender awarded; PPA signed; Exploration expected to commence this year	PLN withdrew from development; Current developer: PT Medco Cahaya Geothermal; Price at US 7.55 cents/ kWh; The plant likely not to be completed by 2014

4	PLTP Iyang Argopuro	East Java	1 x 55	55	Reaffirmed as part of the government crash programme* with the accelerated development of the 30km of 150 kV transmission; Exploration is not yet commenced; Preliminary survey expected to commence (by PT PGE); In the process of getting the permit for land clearing from the Ministry of Forestry	PLN withdrew from development; Developer: PT PGE; The plant likely not to be completed by 2014
5	PLTP Wilis/ Ngebel	East Java	3 x 55	165	Reaffirmed as part of the government crash programme* with the accelerated development of the 60km of 150 kV transmission; Tender awarded, PPA signed; Exploration expected to commence this year	PLN withdrew from development; Current developer is PT Bakrie Power; Price at US 8.55 cents/ kWh; The plant likely not to be completed by 2014
6	PLTP Sungai Penuh	Jambi	2 x 55	110	Reaffirmed as part of the government crash programme* with the accelerated development of the 20km of 150 kV transmission; loan received from ADB (Asian Development Bank) – as part of USD500 million; Exploration conducted in 2011	Developer: PT PGE (PT PLN*); PLTP Sungai Penuh is located in the protection/ conservation forest area; Transmission to be developed by PT PLN; The plant expected to operate by 2014
7	PLTP Hululais	Bengkulu	2 x 55	110	Reaffirmed as part of the government crash programme* with the accelerated development of the 120km of 150 kV transmission; Exploration conducted in 2011	Developer; PT PGE (PT PLN*); The plant expected to operate 2013
8	PLTP Kotamobagu I & II	North Sulawesi	2 x 20	40	Reaffirmed as part of the government crash programme* with the accelerated development of the 32km of 150 kV transmission; PPA signed (April 2010); Exploration conducted in 2011 for Unit I & II; In the process of getting the permit for land clearing from the Ministry of Forestry	Developer: PT PGE (PT PLN*); Two units of the plants expected to operate by the end of 2013 and the rest by 2014
9	PLTP Kotamobagu III & IV	North Sulawesi	2 x 20	40		

10	PLTP Sembalun	West Nusa Tenggara	2 x 10	20	Reaffirmed as part of the government crash programme* with the accelerated development of the 60km of 150 kV transmission; In the process of getting the permit for land clearing from the Ministry of Forestry	Developer: PT PLN*; PLTP Sembalun is located in the protection/ conservation forest area; The plant likely not to be completed by 2014
11	PLTP Tulehu	Maluku	2 x 10	20	Reaffirmed as part of the government crash programme* with the accelerated development of the 6km of 70 kV transmission; Loan received from JBIC (Japan Bank for International Cooperation) USD80 million;	Developer: PT PLN*; The plant expected to operate by 2014
IPPs (Independent Power Producers)						
1	PLTP Rawa Dano	Banten	1 x 110	110	Reaffirmed as part of the government crash programme* with the accelerated development of the 30km of 150 kV transmission; Tender awarded; Reconnaissance survey this year	Developer: Sintesa Green Energy and PT Banten Global Synergy; The plant likely not to be completed by 2014
2	PLTP Cibuni	West Java	1 x 10	10	Reaffirmed as part of the government crash programme* with the accelerated development of the 50km of 70 kV transmission; Awaiting for follow-up on exploration	Developer: KJK Yala Teknosa; The plant likely not to be completed by 2014
3	PLTP Cisolok – Cisukarame	West Java	1 x 50	50	Reaffirmed as part of the government crash programme* with the accelerated development of the 60km of 150 kV transmission; PPA in negotiation; PT Rekind has spent 10 percent to financially support PLTP Cisolok (or around USD123 million); Reconnaissance survey conducted; Exploration to commence this year; PPA in negotiation	Developer: PT Jabar Rekind Geothermal (joint venture between PT Jasa Sarana and PT Rekayasa Indonesia); Price proposed at US 6.3 cents/ kWh; The plant expected to operate by 2015
4	PLTP Darajat IV	West Java	2 x 55	110	Production stage; Not reaffirmed as part of the government crash programme;	Developer: Chevron Geothermal Indonesia; The plant expected to operate by 2014

5	PLTP Patuha	West Java	3 x 60	180	Reaffirmed as part of the government crash programme* with the accelerated development of the 70km of 150 kV transmission; Exploration conducted; Permits for land clearing secured; Environmental Impact Assessment (EIA) completed; Projected investment costs USD300 million;	Developer: Geo Dipa Energy; The plant expected to operate by 2014
6	PLTP Karaha Bodas	West Java	1 x 30, 2 x 55	140	Reaffirmed as part of the government crash programme* with the accelerated development of the 20km of 150 kV transmission; PPA signed (March 2011); In the process of getting the permit for land clearing from the Ministry of Forestry	Developer: PT PGE; Price at USD8.25 cents/ kWh; The plants expected to operate by 2014
7	PLTP Salak	West Java	1 x 40	40	Production stage; Not reaffirmed as part of the government crash programme;	Developer: Chevron Geothermal Indonesia; The plant expected to operate by 2014
8	PLTP Tampomas	West Java	1 x 45	45	Reaffirmed as part of the government crash programme* with the accelerated development of the 35km of 150 kV transmission; PPA in negotiation; Exploration to commence this year	Developer: PT Wika Jabar Power (joint venture between PT Jasa Sarana and PT Wijaya Karya); The plant expected to operate by 2014
9	PLTP Tangkuban Perahu II	West Java	2 x 30	60	Reaffirmed as part of the government crash programme* with the accelerated development of the 5km of 150 kV transmission; Tender awarded; PPA in negotiation; Exploration not yet commenced	Developer: Tri Energy; Price is not yet agreed; Developer demanding government guarantees for exploration and construction; The plant likely not to be completed by 2014

10	PLTP Wayang Windu III & IV	West Java	2 x 110	220	Reaffirmed as part of the government crash programme*; Tender prepared; In the process of getting the permit for land clearing from the Ministry of Forestry; Projected investment costs USD300 million; Exploration completed; Construction expected to commence	Developer: Star Energy Geothermal Ltd.; PLTP Wayang Windu is located in the protection forest area; West Java provincial government requesting to have a percentage of shares; The plant expected to operate by 2015
11	PLTP Baturaden	Central Java	2 x 110	220	Reaffirmed as part of the government crash programme* with the accelerated development of the 20km of 150 kV transmission; PPA signed; Exploration commenced; In the process of getting the permit for land clearing from the Ministry of Forestry	Developer: Tri Energy; Price at USD9.47 cents/ kWh; Developer demanding government guarantees for exploration and construction; 175 MW of the plant expected to operate by 2014
12	PLTP Dieng	Central Java	1 x 55, 1 x 60	115	Reaffirmed as part of the government crash programme*; Wells are being optimized; Projected investment costs USD300 million;	Developer: Geo Dipa Energy; Current price at US 4.45 cents/ kWh (proposed price 7-9.7 cents/ kWh); Reported to have public negative perception; The plant expected to operate by 2014
13	PLTP Guci	Central Java	1 x 55	55	Reaffirmed as part of the government crash programme* with the accelerated development of the 20km of 150 kV transmission; In the process of getting the permit for land clearing from the Ministry of Forestry; Tender completed; Exploration commenced	Developer: PT Spring Energy; Price at US 9.09 cents/ kWh; The plant expected to operate by 2014

14	PLTP Ungaran	Central Java	1 x 55	55	Reaffirmed as part of the government crash programme* with the accelerated development of the 40km of 150 kV transmission; Tender awarded (valued approximately at USD300 million); PPA signed (April 2011); In the process of getting the permit for land clearing from the Ministry of Forestry; Exploration commenced	Developer: PT Giri Indah Sejahtera; Price at US 8.09 cents/ kWh; The plant expected to operate by 2014
15	PLTP Seulawah Agam	Nanggroe Aceh Darussalam	1 x 55	55	Reaffirmed as part of the government crash programme* with the accelerated development of the 16km of 150 kV transmission; Tender processed in 2010; Projected investment costs approximately at US$180 million (loan agreed at EUR56 million and grant received at EUR7 million from German government)	Developer: Aceh Provincial Government; The plant expected to operate by 2015
16	PLTP Jaboi	Nanggroe Aceh Darussalam	2 x 5	10	Reaffirmed as part of the government crash programme*; PPA in negotiation; Exploration to commence in 2011;	Developer: PT Sabang Geothermal Energy; The plant expected to operate by 2013
17	PLTP Sarulla I	North Sumatra	3 x 110	330	Reaffirmed as part of the government crash programme*; Confirmation agreement signed (April 2010); Barrier: Asset ownership (as part of loan agreement from JBIC); The price issue solved; Land acquisition solved;	Developer: consortium for PLTP Sarulla (Orsarulla Incorporation, Sarulla Power Aset Ltd, Sarulla Operation Ltd, PT Medco Geopower Sarulla dan Kyuden Sarulla PTE, Ltd.); Price at US$6.79 cents/ kWh; Unit I of the plants expected to operate by 2013
18	PLTP Sarulla II	North Sumatra	2 x 55	110		

19	PLTP Sorik Marapi	North Sumatra		240	Reaffirmed as part of the government crash programme* with the accelerated development of the 46km of 150 kV transmission; Tender is processed in 2010; Awarded to the Consortium of Tata-Supraco-Origin (but facing litigation/law suit from Medco-Ormat in 2011); Exploration commenced in 2011;	Developer: Consortium of Supraco-Tata Power-Origin; Price at US$8.10 cents/ kWh; The plant expected to operate by 2014
20	PLTP Muara Laboh	West Sumatra	2 x 110	220	Reaffirmed as part of the government crash programme*; PPA signed (March 2012): Reported in 2011 to have a financial support issue; Projected investment costs at US650 million (exploration costs US$60-70 million)	Developer: Consortium of Supreme Energy-International Power GDF Suez-Sumitomo Corporation; Price at US$9.4 cents/ kWh The plant expected to operate by 2016
21	PLTP Lumut Balai	South Sumatra	4 x 55	220	Reaffirmed as part of the government crash programme*; PPA signed (March 2011); In the process of getting the permit for land clearing from the Ministry of Forestry; Loan received from JICA (Japan International Cooperation Agency)	Developer: PT PGE; Price at US$7.53 cents/ kWh; The plant expected to operate by 2014
22	PLTP Rantau Dadap	South Sumatra	2 x 110	220	Reaffirmed as part of the government crash programme*; Tender awarded; PPA to be signed	Developer: Consortium of Supreme Energy-GDF Suez-Marubeni Corporation; The plant likely not to be completed by 2014
23	PLTP Rajabasa	Lampung	2 x 55	220	Reaffirmed as part of the government crash programme*; PPA signed (March 2012); Reported in 2011 to have a financial support issue; In the process of getting the permit for land clearing from the Ministry of Forestry; Projected investment costs at US$700 million	Developer: Consortium of Supreme Energy-International Power GDF Suez-Sumitomo Corporation; Price at US$9.5 cents/ kWh; PLTP Rajabasa is located in the protection forest area; The plant expected to operate by 2016

24	PLTP Ulubelu III & IV	Lampung	2 x 20	110	Reaffirmed as part of the government crash programme*; PPA signed (March 2011); Drilling activities (2011); Loan agreed from the World Bank	Developer: PT PGE; Price at US$7.53 cents/ kWh; The plants expected to operate by 2014
25	PLTP Lahendong V & VI	North Sulawesi	2 x 20	40	Reaffirmed as part of the government crash programme*; PPA signed (March 2011); Exploration and exploitation conducted	Developer: PT PGE; Price at US$8.25 cents/ kWh; The plants expected to operate by 2013
26	PLTP Bora	Central Sulawesi	1 x 5	5	Reaffirmed as part of the government crash programme*; Reconnaissance survey conducted;	The plant likely not to be completed by 2014
27	PLTP Marana/ Masaingi	Central Sulawesi	2 x 10	20	Reaffirmed as part of the government crash programme*; Tender processed;	The plant likely not to be completed by 2014
28	PLTP Mangolo	Southeast Sulawesi	2 x 5	10	Not reaffirmed as part of the government crash programme; No proposed geothermal working areas yet	PLTP Mangolo is located in the protection/ conservation forest area; The plant likely not to be completed by 2014
29	PLTP Hu'u	West Nusa Tenggara	2 x 10	20	Reaffirmed as part of the government crash programme*; Tender processed;	The plant likely not to be completed by 2014
30	PLTP Atadei	East Nusa Tenggara	2 x 2.5	5	Reaffirmed as part of the government crash programme*; Tender processed; PPA signed (March 2011); US$50 million allocated;	Developer: PT Westindo Utama Karya (PT Atadei Geothermal Indonesia); Price at US$9 cents/ kWh; The plant expected to operate by 2014
31	PLTP Sokoria	East Nusa Tenggara	3 x 5	15	Reaffirmed as part of the government crash programme*; PPA still in negotiation (expected to be signed); Reported to have negative perception from the public (2009); In the process of getting the permit for land clearing from the Ministry of Forestry; Rezoning agreed by Ministry of Energy and Mineral Resources (exploration and exploitation to be outside protection and conservation forests)	Developer: Bakrie Group; PLTP Sokoria is located in the protection/ conservation forest area; The plant likely not to be completed by 2014

32	PLTP Jailolo	North Maluku	2 x 5	10	Reaffirmed as part of the government crash programme*; Block granted; PPA in negotiation; Projected investment costs at US$110 million (a grant of US$732,722 received from the US government for feasibility study performed by AECOM USA); Exploration to be commenced in 2010 (by ELC Electroconsult);	Developer: PT Star Energy Halmahera; Proposed price at US$17 cents/ kWh (higher than the maximum allowable price set by the government at US$9.7 cents/ kWh); Developer demanding purchasing price above government's price; The plant expected to operate by 2014
33	PLTP Songa Wayaua	North Maluku	1 x 5	5	Reaffirmed as part of the government crash programme*; Ready to be offered;	The plant likely not to be completed by 2014
34	PLTP Gunung Endut	Banten	1 x 55	55	Inserted as part of the government crash programme* with the accelerated development of the 80km of 150 kV transmission; PLN has expressed interest	The plant likely not to be completed by 2014
35	PLTP Gunung Ciremai	West Java	2 x 55	110	Inserted as part of the government crash programme* with the accelerated development of the 40km of 150 kV transmission; PLN and PT Chevron Indonesia have expressed their interests; Tender process unknown	The plant likely not to be completed by 2014
36	PLTP Umbul Telumoyo	Central Java	1 x 55	55	Inserted as a new part of the government crash programme*; Ready to be offered	The plant likely not to be completed by 2014
37	PLTP Simbolon Samosir	North Sumatra	2 x 55	110	Inserted as a new part of the government crash programme*; Ready to be offered; PLN expressed interest	The plant likely not to be completed by 2014
38	PLTP Sipoholon Ria-Ria	North Sumatra	1 x 55	55	Inserted as a new part of the government crash programme*; Ready to be offered; PLN expressed interest	The plant likely not to be completed by 2014
39	PLTP Bonjol	West Sumatra	3 x 55	165	Inserted as a new part of the government crash programme*; Ready to be offered; PLN expressed interest	The plant likely not to be completed by 2014

40	PLTP Suoh Sekincau	Lampung	4 x 55	220	Inserted as a new part of the government crash programme*; Ready to be offered; PLN expressed interest	The plant likely not to be completed by 2014
41	PLTP Wai Ratai	Lampung	1 x 55	55	Inserted as a new part of the government crash programme*; Ready to be offered; PLN expressed interest	The plant likely not to be completed by 2014
42	PLTP Danau Ranau	Lampung	2 x 55	110	Inserted as a new part of the government crash programme*; Ready to be offered; PLN expressed interest	The plant likely not to be completed by 2014
43	PLTP Mataloko	Lampung	1 x 5	5	Inserted as a new part of the government crash programme*; Ready to be offered; PLN expressed interest (PLN previously developed a pilot site currently running at 1.8 MW capacity (out of planned 2MW).	The plant likely not to be completed by 2014

ANNEX D:

List of key geothermal law and regulations

(source: President of the Republic of Indonesia 2010; *Reegle* 2010; Sanyal 2011; Suryadarma 2010; Suryantoro et al. 2005;)

Year	Type of Policy	Number	Subject	Analysis
1974-1991	Presidential Decrees	16 or 1974, 22 of 1981, 23 of 1981, 45 of 1991 & 49 of 1991	Initial policies/ regulations which promote geothermal development	These decrees appointed Pertamina to conduct exploration and exploitation, and to utilize the steam into energy. During this period, private sectors had signed 12 contract areas that were mostly big scale geothermal development and were committed to develop and utilize 3800 MW of geothermal power. Monetary crisis that occurred in mid of 1997 significantly impacted Indonesia economy and put a halt on geothermal energy development.
2000	Presidential Decree	76 of 2000	Geothermal utilization for power generation	This regulation was unsuccessful in luring investors to engage in geothermal development because Indonesia was still in economic recovery stage at that time.
2003	Law	27 of 2003	Geothermal	• This law mainly deregulates the right of regional autonomy (gives more power to provincial and district governments), fiscal reform, sanctity of existing contract, and introduces the transparency process and level of playing field, and regulates the geothermal steam field license. • Most provinces and districts, however have very limited capacity in supporting the acceleration of geothermal development. This capacity issue has been acknowledged as one of key barriers to push for geothermal energy development. • Geothermal development activities are considered as mining activities. As a result, geothermal cannot be developed in protection/conservation forest areas (illegal to have mining activities in these areas according to Law No. 41 of 1999.
2007	Government Regulation	59 of 2007	Geothermal business activities	The Geothermal Blueprint and Roadmap of Geothermal Development in Indonesia until the year of 2025 were declared. The plan is to utilize and develop up to 4,000 MW of geothermal power capacity by 2015 with a longer-term target of 9,500 MW by 2025.
2008	MEMR Regulation	11 of 2008	Mechanisms for determining geothermal working area	

2009	MEMR Regulation	2 of 2009	Guidelines for geothermal pre-survey assignment	
2009	MEMR Regulation	5 of 2009	Guidelines for electricity purchasing price	This regulation issued to attract the increase of investment in facing 4,733 MW geothermal plants in 2014.
2009	MEMR Regulation	11 of 2009	Guidelines for geothermal enterprises	
2009	MEMR Regulation	32 of 2009	Purchasing price arrangements for PLN	
2010	MEMR Decree	15 of 2010	Fast track program II	An ambitious plan to have an additional 3,967 MW of geothermal capacity to be commissioned by the end of 2014
2011	MoF Decree	77 of 2011	Guidelines for government guarantee for PLN power projects	Although this provides additional guarantee for geothermal projects, some developers are still demanding government guarantees for exploration and construction
2011	Ministerial Decree	2 of 2011	Geothermal purchasing price	The maximum allowable price set by the government is at US$ but some developers demand for more (e.g. even reaching US$17 cents/kWh in the case of PLTP Jailolo)
2011	Presidential Regulation	28 of 2011	Allowing underground mining (geothermal) to be developed in protection and/or conservation forests	This policy is a direct intervention from the Indonesian President to accelerate the development of geothermal energy on protection/ conservation forest areas. To make this case stronger, there is still a need to revise/ amend the 2003 Geothermal Law.
2011	Joint Agreement (MEMR and MoForestry)	7662 of 2011	Joint coordination and acceleration of the permits to develop geothermal energy in forest production and protection areas as well as in forest conservation areas.	This agreement is effective for three years following its signing. This is a bridging policy to support the development of geothermal energy on protection/ conservation forest areas.
2011	MEMR Decree	1 of 2012	Re-affirming the acceleration of renewable energy (including geothermal) development in the government crash programme	There is omission but mostly addition of new geothermal working areas (WKPs) which are inserted in this revised crash programme. By observing Table 4, of the total 4,925 MW set as a target in this decree, there are at maximum only 2,405 MW projected to be developed by 2014.

100%
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About WWF Ring of Fire Program

With the Ring of Fire Program, WWF has an ambition: by 2015 there is a significant shift towards the use of renewable energy and particularly in the sustainable production and use of geothermal energy in Indonesia and the Phillipines.

Improved Enabling Environment

By 2015, an improved enabling environment conducive to geothermal energy and other RES will be in place in Indonesia and the Philippines.

WWF's 100% Renewable Vision

By 2015, Indonesia has agreed to national renewable energy targets for 2030 in line with WWF's 100% renewable vision, including a target for ending energy poverty by 2030. By 2015, the targets for the Philippines will be more ambitious than the 2030 target announced by government.

WWF's Sustainability Criteria

By 2015, WWF's Sustainability Criteria shall have been accepted by the geothermal industry as a best practice benchmark, has significantly improved geothermal energy's social acceptability and built broad stakeholder support.

WWF strengths of working in partnership with the public and private sector, and combining expertise with on the ground implementation, will form the basis of our approach. Furthermore, WWF has been 50 years of experience in the region. WWF intends to use this program as a catalyst to accelerate geothermal development in other countries within the region - and potentially in other regions with rich geothermal energy potential.

The program will show it is possible to achieve this ambition in a sustainable way, conserving biodiversity, and at the same time support innovation and green economic growth, counter climate change and improve the living conditions of targeted communities. A rightly approached 'Green New Deal' works on energy supply, environment protection, employment creation and economic growth.

WWF

Why we are here
To stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature

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